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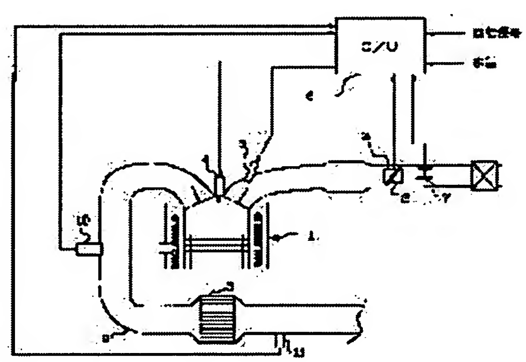
(54) EXHAUST EMISSION CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To restrain exhaust of HC and CO while efficiently purifying NOx by controlling the air-fuel mixture air-fuel ratio by making a feedback process to reverse the downstream side exhaust air-fuel ratio of an NOx absorbing catalyst to rich just after the target air-fuel ratio of an air-fuel mixture is switched to the theoretical air-fuel ratio or rich from lean.



SOLUTION: Air-fuel ratio sensors 10 and 11 are respectively arranged on the upstream-downstream sides of an NOx absorbing catalyst 5 of an exhaust system, and just after the target air-fuel ratio of an air-fuel mixture is switched to the theroretial air-fuel ratio or rich from lean, by an ECU 6, air-fuel ratio feedback control is performed by using the downstream side sensor 11 instead of the upstream side sensor 10. At this time, since reversal to rich of the downstream side sensor 11 delays by removal of NOx and O2 in the catalyst 5, even if the exhaust air-fuel ratio detected by the upstream side sensor 10 reverses to rich, a fuel injection quantity is controlled so as to be gradually increased until the downstream side sensor 11 reverses to rich further, and reversal to rich of the downstream side sensor 11 is quickened.

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CLAIMS

[Claim(s)]
[Claim 1] theoretical air fuel ratio or when rich, while NOx under exhaust air when an exhaust-air air-fuel ratio is Lean absorbs, and an exhaust-air air-fuel ratio emits said NOx which absorbed and is equipped with the NOx absorption catalyst which carries out reduction processing -- combustion -- the target air-fuel ratio of gaseous mixture reverses richly the exhaust-air air-fuel ratio of the downstream of said NOx absorption catalyst theoretical air fuel ratio or immediately after switching richly from Lean -- it should make -- combustion -- the exhaust emission control device of the internal combustion engine characterized by to carry out the feedback control of the air-fuel ratio of gaseous mixture.
[Claim 2] The exhaust emission control device of the internal combustion engine according to claim 1 characterized by making a feedback control input when the downstream of said NOx absorption catalyst is equipped with a three way component catalyst and the exhaust air air-fuel ratio of the downstream of said NOx absorption catalyst is richly reversed hold until the exhaust air air-fuel ratio of the downstream of said three way component catalyst is richly reversed from said time of being richly reversed.
[Claim 3] The exhaust emission control device of the internal combustion engine according to claim 1 characterized by carrying out predetermined time maintenance of the feedback control input when the downstream of said NOx absorption catalyst is equipped with a three way component catalyst and the exhaust air air-fuel ratio of the downstream of said NOx absorption catalyst is richly reversed from said time of being richly reversed.
[Claim 4] The NOx absorption catalyst which absorbs NOx under exhaust air when an exhaust air air-fuel ratio is Lean, and an exhaust air air-fuel ratio emits said absorbed NOx, and carries out reduction processing theoretical air fuel ratio or when rich, In a 1st air-fuel ratio detection means to detect an exhaust air air-fuel ratio by the upstream of this NOx absorption catalyst, a 2nd air-fuel ratio detection means to detect an exhaust air air-fuel ratio by the downstream of said NOx absorption catalyst, and a normal state the exhaust air air-fuel ratio detected with said 1st air-fuel ratio detection means -- being based -- combustion -- with the 1st air-fuel ratio feedback means which carries out feedback control of the air-fuel ratio of gaseous mixture to a target air-fuel ratio The target air-fuel ratio of gaseous mixture only sets theoretical air fuel ratio or immediately after switching richly from Lean. combustion -- the exhaust air air-fuel ratio detected with said 2nd air-fuel ratio detection means -- being based -- combustion -- the exhaust emission control device of the internal combustion engine characterized by being constituted including the 2nd air-fuel ratio feedback means which carries out feedback control of the air-fuel ratio of gaseous mixture to a target air-fuel ratio.
[Claim 5] The exhaust emission control device of the internal combustion engine according to claim 4 characterized by performing feedback control in between until the exhaust air air-fuel ratio with which said 2nd air-fuel ratio feedback means is detected with said 2nd air-fuel ratio detection means from a switch of a target air-fuel ratio is richly reversed.
[Claim 6] The exhaust emission control device of the internal combustion engine according to claim 5 characterized by having a forcible stop means to stop compulsorily the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means when not richly reversed [with the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means], even if the predetermined maximum

time amount passed.
[Claim 7] The exhaust emission control device of the internal combustion engine according to claim 5 or 6 with which it has a study means to learn the control input when being richly reversed with the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means as a study value, and said 2nd air-fuel ratio feedback means is characterized by only said study value carrying out step change of the control input at the time of initiation of feedback control of air-fuel ratio.
[Claim 8] The exhaust emission control device of the internal combustion engine according to claim 7 characterized by establishing the study value reduction correction means which makes the reduction correction of said study value when richly reversed [with the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means] within the predetermined minimum time amount.
[Claim 9] The three way component catalyst arranged at the downstream of said NOx absorption catalyst, and a 3rd air-fuel ratio detection means to detect an exhaust air air-fuel ratio by the downstream of this three way component catalyst, The control input by the 2nd air-fuel ratio feedback control means at the time of the exhaust air air-fuel ratio detected with said 2nd air-fuel ratio detection means being richly reversed The exhaust emission control device of the internal combustion engine of any one publication of claim 5-8 characterized by establishing the rich control input maintenance means made to hold until the exhaust air air-fuel ratio detected with said 3rd air-fuel ratio detection means is richly reversed.
[Claim 10] The exhaust emission control device of the internal combustion engine of any one publication of claim 5-8 characterized by establishing the rich control input maintenance means by the time amount which carries out predetermined time maintenance of the control input by the 2nd air-fuel ratio feedback control means at the time of the three way component catalyst arranged at the downstream of said NOx absorption catalyst and the exhaust air air-fuel ratio detected with said 2nd air-fuel ratio detection means being richly reversed after that.
[Claim 11] The exhaust emission control device of the internal combustion engine according to claim 10 with which the rich control input maintenance means by said time amount is characterized by changing the time amount which makes said control input hold according to the time amount by which said three way component catalyst was exposed to lean atmosphere.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the technique for controlling to the optimal air-fuel ratio required for purification of NOx in detail about an internal combustion engine's exhaust emission control device in the internal combustion engine which equipped the flueway with the NOx absorption catalyst.
[0002]
[Description of the Prior Art] NOx under exhaust air from the former when an exhaust air air-fuel ratio is Lean is absorbed, and the engine with which the exhaust air air-fuel ratio was equipped with the NOx absorption catalyst (NOx absorption mold three way component catalyst) which emits said absorbed NOx and carries out reduction processing theoretical air fuel ratio (SUTOIKI) or when rich is known (reference, such as JP,7-139397,A).
[0003]
[Problem(s) to be Solved by the Invention] Although said NOx absorption catalyst reduces the amount of NOx which absorbs NOx during the Lean combustion and is discharged in atmospheric air as shown in drawing 14, if an absorbed amount exceeds a peak, it will be discharged in atmospheric air as it is, without NOx discharged by the engine being absorbed by the catalyst.
[0004] Then, when it is presumed based on a load, rotation, an air-fuel ratio, etc. that the NOx absorbed amount in an NOx absorption catalyst has reached the peak, he is trying to make theoretical air fuel ratio or emission of NOx which switches richly and is absorbed by the NOx absorption catalyst, and reduction processing perform a target air-fuel ratio compulsorily. However, it is a target air-fuel ratio The theoretical air fuel ratio or NOx absorbed by the NOx absorption catalyst even if switched richly from Lean, and O2 In order that the inside of a catalyst may not make it rich easily, HC and CO of NOx required for reduction will oxidize in lean atmosphere, and it will be discharged by desorption, without purifying NOx efficiently (refer to drawing 14).
[0005] Therefore, when making NOx purify, making the inside of an NOx absorption catalyst make it rich promptly is required, and it is effective to give a rich spike for that purpose. However, when an NOx absorption catalyst carries out degradation with the passage of time, it is the maximum absorbed amount of NOx, and O2. Since storage capacity changed, when the NOx absorption catalyst of a new article condition was made to suit and said amount of rich spikes was set up uniformly, there was a problem of a rich spike becoming superfluous at the time of degradation, and increasing the discharge of HC and CO.
[0006] Moreover, NOx discharged from an NOx absorption catalyst, without being purified even if it is the case where the optimal rich spike is given may occur, and this cannot be canceled depending on increase of a rich amount, but superfluous rich control produces the problem of increasing the discharge of HC and CO as mentioned above. It aims at offering the exhaust emission control device which can control discharge of HC and CO, being able to control to the optimal air-fuel ratio for NOx purification, with purifying NOx efficiently, even if this invention is made in view of the above-mentioned trouble and degradation of an NOx absorption catalyst with the passage of time arises.
[0007] Moreover, even if there is NOx discharged without being returned from an NOx absorption catalyst, it aims at offering the exhaust emission control device which processes this certainly and

can inhibit discharge into atmospheric air.
[0008]
[Means for Solving the Problem] Therefore, invention according to claim 1 absorbs NOx under exhaust air when an exhaust air air-fuel ratio is Lean. The target air-fuel ratio of gaseous mixture sets theoretical air fuel ratio or immediately after switching richly from Lean. theoretical air fuel ratio or when rich, while an exhaust air air-fuel ratio emits said absorbed NOx and is equipped with the NOx absorption catalyst which carries out reduction processing -- combustion -- the exhaust air air-fuel ratio of the downstream of said NOx absorption catalyst is reversed richly -- it should make -- combustion -- it considered as the configuration which carries out feedback control of the air-fuel ratio of gaseous mixture.
[0009] When it is the conditions to which purification of NOx by which the target air-fuel ratio was absorbed by the NOx absorption catalyst during the Lean combustion theoretical air fuel ratio or immediately after switching richly from Lean is carried out according to this configuration, feedback control of air-fuel ratio is performed in order to reverse richly the exhaust air air-fuel ratio of the downstream of an NOx absorption catalyst from Lean. In addition, since the NOx absorbed amount to an NOx absorption catalyst besides a switch of the target air-fuel ratio according [a switch of said target air-fuel ratio] to change of service conditions, such as acceleration, came to the limitation, a target air-fuel ratio includes temporarily theoretical air fuel ratio or the case where it is switched richly.
[0010] If it puts in another way, since it is influenced by an NOx absorbed amount, the amount of oxygen storage, etc. at that time and changes with response delay to change of an entrance side, the ambient atmosphere within an NOx absorption catalyst has not reached [the exhaust air air-fuel ratio of the outlet side of an NOx absorption catalyst, and] a target in an outlet side, even if the entrance side has reached the target. Then, even if it makes feedback control of air-fuel ratio perform based on the exhaust air air-fuel ratio of an outlet side and an entrance side reaches a target, an outlet side can bring forward air-fuel ratio change of an outlet side (inside of a catalyst) by changing an air-fuel ratio to a target, until.
[0011] In invention according to claim 2, the downstream of said NOx absorption catalyst was equipped with the three way component catalyst, and it considered as the configuration which makes a feedback control input when the exhaust air air-fuel ratio of the downstream of said NOx absorption catalyst is richly reversed hold until the exhaust air air-fuel ratio of the downstream of said three way component catalyst is richly reversed from said time of being richly reversed. According to this configuration, a three way component catalyst is further arranged to the downstream of an NOx absorption catalyst. And the control input (for example, correction factor for amending fuel oil consumption) of the air-fuel ratio at that time is made to hold, if the downstream of an NOx absorption catalyst is richly reversed after a switch of a target air-fuel ratio with the above-mentioned feedback control of air-fuel ratio until the downstream of said three way component catalyst is richly reversed.
[0012] That is, although said three way component catalyst tends to purify NOx which was not able to be purified with an NOx absorption catalyst by forming said three way component catalyst, it is necessary to make rich promptly the inside of said three way component catalyst in order to make purification with said three way component catalyst perform efficiently. then, the thing made for the control input reversed richly to clamp the inside of an NOx absorption catalyst -- combustion -- the air-fuel ratio of gaseous mixture is held richly, and after the inside of a three way component catalyst is richly reversed, it is made to make it usually shift to control
[0013] In invention according to claim 3, the downstream of said NOx absorption catalyst was equipped with the three way component catalyst, and the feedback control input when the exhaust air air-fuel ratio of the downstream of said NOx absorption catalyst is richly reversed was considered as the configuration which carries out predetermined time maintenance from said time of being richly reversed. After starting the clamp of said control input, when only predetermined time has passed, the exhaust air air-fuel ratio of the downstream of a three way component catalyst presumes what is reversed richly, and makes it usually return to control after said predetermined time progress with this configuration.
[0014] On the other hand, invention according to claim 4 is constituted as shown in drawing 1 . In

drawing 1 , an NOx absorption catalyst absorbs NOx under exhaust air when an exhaust air air-fuel ratio is Lean, and is a catalyst which an exhaust air air-fuel ratio emits said absorbed NOx theoretical air fuel ratio or when rich, and carries out reduction processing. The 1st air-fuel ratio detection means detects an exhaust air air-fuel ratio by the upstream of an NOx absorption catalyst, and the 2nd air-fuel ratio detection means detects an exhaust air air-fuel ratio by the downstream of an NOx absorption catalyst.
[0015] the exhaust air air-fuel ratio with which the 1st air-fuel ratio feedback means is detected with said 1st air-fuel ratio detection means in a normal state -- being based -- combustion -- feedback control of the air-fuel ratio of gaseous mixture is carried out to a target air-fuel ratio. the 2nd air-fuel ratio feedback means -- combustion -- the exhaust air air-fuel ratio with which the target air-fuel ratio of gaseous mixture is detected with said 2nd air-fuel ratio detection means theoretical air fuel ratio or immediately after switching richly from Lean -- being based -- combustion -- feedback control of the air-fuel ratio of gaseous mixture is carried out to a target air-fuel ratio.
[0016] According to this configuration, feedback control is performed in order usually bringing the exhaust-air air-fuel ratio detected by the upstream of an NOx absorption catalyst close to a target air-fuel ratio, but when it is the conditions to which purification of NOx which the target air-fuel ratio absorbed in the NOx absorption catalyst theoretical air fuel ratio or immediately after switching richly from Lean is carried out, it replaces with the above-mentioned feedback control, and feedback control is performed in order the exhaust-air air-fuel ratio detected by the downstream of an NOx absorption catalyst close to a target air-fuel ratio.
[0017] Since the exhaust air air-fuel ratio of the downstream of an NOx absorption catalyst is in the change compared with the upstream, it is performing the 2nd air-fuel ratio feedback control means based on the exhaust air air-fuel ratio of the downstream, and will bring forward change of the exhaust air air-fuel ratio of the downstream. In addition, the sensor which detects an exhaust air air-fuel ratio as a 1st and 2nd air-fuel ratio detection means based on the oxygen density under exhaust air can be used, and the broader-based air-fuel ratio sensor which can detect continuously further an exhaust air air-fuel ratio besides [which detects only Rich Lean to theoretical air fuel ratio] a SUTOIKI sensor may be used.
[0018] In invention according to claim 5, said 2nd air-fuel ratio feedback means considered as the configuration which performs feedback control in between until the exhaust air air-fuel ratio detected with said 2nd air-fuel ratio detection means from a switch of a target air-fuel ratio was richly reversed. Feedback control is carried out so that the exhaust air air-fuel ratio of the downstream of an NOx absorption catalyst may be brought close to a target air-fuel ratio, and it is promptly made richly reversed [the inside of an NOx absorption catalyst] according to this configuration until the exhaust air air-fuel ratio of the downstream of an NOx absorption catalyst is richly reversed from Lean.
[0019] In invention according to claim 6, even if the predetermined maximum time amount passed, when not richly reversed [with the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means], it considered as the configuration equipped with a forcible stop means to stop compulsorily the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means. According to this configuration, it is judged as that in which a certain abnormalities have generated the feedback control of air-fuel ratio based on the exhaust air air-fuel ratio detected with the 2nd air-fuel ratio detection means when not richly reversed in a predetermined time line, said feedback control of air-fuel ratio is stopped, and rich-ization beyond it is not performed.
[0020] In invention according to claim 7, it had a study means to learn the control input when being richly reversed with the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means as a study value, and said 2nd air-fuel ratio feedback means considered as the configuration which only said study value makes carry out step change of the control input at the time of initiation of feedback control of air-fuel ratio. According to this configuration, if the exhaust air air-fuel ratio of the downstream of an NOx absorption catalyst is richly reversed at the time of a switch of a target air-fuel ratio, the control input at that time will be learned as a control input needed for rich reversal. And when starting the feedback control of air-fuel ratio using the 2nd air-fuel ratio detection means, the response of rich reversal is brought forward because only said study value carries out step change of the control input.

[0021] In invention according to claim 8, when richly reversed [with the feedback control of air-fuel ratio by said 2nd air-fuel ratio feedback means] within the predetermined minimum time amount, it considered as the configuration which establishes the study value reduction correction means which makes the reduction correction of said study value. When the downstream of an NOx absorption catalyst is richly reversed earlier than the minimum time amount, a study value presumes a superfluously large thing, and makes the reduction correction of the study value, and it is made richly reversed [value] by the feedback control of air-fuel ratio using the 2nd air-fuel ratio detection means according to this configuration by the middle proper time amount of said maximum time amount and minimum time amount.
[0022] The three way component catalyst arranged in invention according to claim 9 at the downstream of said NOx absorption catalyst, A 3rd air-fuel ratio detection means to detect an exhaust air air-fuel ratio by the downstream of this three way component catalyst, The control input by the 2nd air-fuel ratio feedback control means at the time of the exhaust air air-fuel ratio detected with said 2nd air-fuel ratio detection means being richly reversed It considered as the configuration which establishes the rich control input maintenance means made to hold until the exhaust air air-fuel ratio detected with said 3rd air-fuel ratio detection means is richly reversed.
[0023] According to this configuration, it is arranged from the upstream to a flueway in order of the 1st air-fuel ratio detection means, an NOx absorption catalyst, the 2nd air-fuel ratio detection means, a three way component catalyst, and the 3rd air-fuel ratio detection means. And it is held at the control input at said reversal time until the exhaust air air-fuel ratio detected with the 3rd air-fuel ratio detection means from this reversal time will be richly reversed, if the exhaust air air-fuel ratio detected by said 2nd air-fuel ratio feedback control means with the 2nd air-fuel ratio detection means is richly reversed.
[0024] Namely, since it is necessary to also reverse promptly the exhaust air air-fuel ratio in a three way component catalyst richly so that said three way component catalyst may be for purifying NOx which was not able to be purified with an NOx absorption catalyst and it may make this NOx purification perform efficiently Even if the inside of an NOx absorption catalyst is richly reversed, it is not made to usually return to control (control by the 1st air-fuel ratio feedback control means) immediately. After checking rich-ization of the three way component catalyst which will be made rich later than rich reversal of an NOx absorption catalyst, it is made to usually return to control.
[0025] In invention according to claim 10, it considered as the configuration which establishes the rich control input maintenance means by the time amount which carries out predetermined time maintenance of the control input by the 2nd air-fuel ratio feedback control means at the time of the three way component catalyst arranged at the downstream of said NOx absorption catalyst and the exhaust air air-fuel ratio detected with said 2nd air-fuel ratio detection means being richly reversed after that. According to this configuration, it is the configuration of making the exhaust air air-fuel ratio of the downstream of a three way component catalyst making it rich, but not the configuration that establishes the 3rd air-fuel ratio detection means, and detects an exhaust air air-fuel ratio directly like invention according to claim 9 but the control input which reversed the inside of an NOx absorption catalyst richly is presumed to be what also reverses richly the inside of the three way component catalyst of the downstream by holding only predetermined time.
[0026] In invention according to claim 11, the rich control input maintenance means by said time amount considered as the configuration which changes the time amount which makes said control input hold according to the time amount by which said three way component catalyst was exposed to lean atmosphere. When the time amount (Lean time amount) by which the three way component catalyst was exposed to lean atmosphere is long according to this configuration, there are so many amounts of oxygen storage, and since what takes time amount to be richly reversed is presumed, the time amount which makes the control input which carried out rich reversal of the NOx absorption catalyst hold is changed according to said Lean time amount.
[0027]
[Effect of the Invention] When NOx absorbed by the NOx absorption catalyst is emitted according to invention according to claim 1, while being able to carry out [rich]-izing of the inside of an NOx absorption catalyst promptly, it can control to the optimal air-fuel ratio, without being influenced by fluctuation of an NOx absorbed amount etc., NOx can be returned efficiently, and it is effective in

the ability to control increase of the discharge of HC and CO.
[0028] According to invention according to claim 2, it is effective in the ability to purify efficiently NOx which has arranged the three way component catalyst to the downstream of an NOx absorption catalyst, made rich promptly the inside of said three way component catalyst while being able to attain purification of NOx which was not able to be purified with an NOx absorption catalyst, and was not able to be purified with an NOx absorption catalyst. According to invention according to claim 3, it is effective in the ability to perform control for making the three way component catalyst arranged at the downstream of an NOx absorption catalyst make it rich at an early stage simple.
[0029] While the exhaust-air air-fuel ratio usually introduced into an NOx absorption catalyst using the air-fuel ratio detection means formed in the upstream of an NOx absorption catalyst is controllable proper according to invention according to claim 4, the inside of an NOx absorption catalyst can be promptly made rich under the condition to which NOx purification is carried out in an NOx absorption catalyst, and it is effective in the ability to be able to purify NOx efficiently, controlling the discharge of HC and CO.
[0030] While according to invention according to claim 5 being able to change an NOx absorption catalyst even to the optimal air-fuel ratio for reduction processing of NOx promptly and being able to purify NOx efficiently, it is effective in the ability to control increase of the discharge of HC and CO. According to invention according to claim 6, it is effective in the ability to prevent that rich control is superfluously carried out by the feedback control of air-fuel ratio based on the exhaust air air-fuel ratio of the downstream of an NOx absorption catalyst.
[0031] According to invention according to claim 7, it is effective in the responsibility of the control which reverses the inside of an NOx absorption catalyst richly from Lean being controllable to a proper value according to each engine and a catalyst. According to invention according to claim 8, the responsibility of the control which reverses the inside of an NOx absorption catalyst richly from Lean becomes early superfluously, and it is effective in the ability of HC and the rate of CO purification to prevent that aggravation falls.
[0032] According to invention according to claim 9, it is effective in the ability to purify efficiently NOx which have arranged the three way component catalyst to the downstream of an NOx absorption catalyst, the correct level was made to make rich promptly the inside of said three way component catalyst while being able to attain purification of NOx which was not able to be purified with an NOx absorption catalyst, and was not able to be purified with an NOx absorption catalyst. According to invention according to claim 10, there is effectiveness of the ability to make it perform simple about the control for making the three way component catalyst arranged at the downstream of an NOx absorption catalyst make it rich at an early stage, without forming an air-fuel ratio detection means in the downstream of a three way component catalyst.
[0033] According to invention according to claim 11, there is effectiveness of the ability to make the inside of the three way component catalyst arranged at the downstream of an NOx absorption catalyst make it rich at an early stage the neither more nor less by the simple configuration.
[0034]
[Embodiment of the Invention] The gestalt of operation of this invention is explained below. Drawing 2 is drawing showing an internal combustion engine's system configuration in the gestalt of the 1st operation, the air measured by the throttle valve 2 is attracted by the engine 1, the fuel injected from a fuel injection valve 3 and said inhalation air are mixed to him, and gaseous mixture is formed in him.
[0035] Said fuel injection valve 3 may inject a fuel into a suction-port part, and may inject a direct fuel to a combustion chamber. Said gaseous mixture carries out ignition combustion by jump spark ignition by the ignition plug 4, and after combustion exhaust air is purified with the NOx absorption catalyst 5 infixed in the flueway 9, it is discharged in atmospheric air. Said NOx absorption catalyst 5 is a catalyst (NOx absorption mold three way component catalyst) which NOx under exhaust air when an exhaust air air-fuel ratio is Lean is absorbed, an exhaust air air-fuel ratio emits said absorbed NOx theoretical air fuel ratio or when rich, and carries out reduction processing in a three way component catalyst layer.
[0036] The control unit 6 which controls fuel injection timing by said fuel injection valve 3, the injection quantity, the ignition timing by the ignition plug 4, etc. is constituted including a

microcomputer, by data processing based on the detecting signal from various sensors, outputs a fuel-injection signal (injection pulse signal) to said fuel injection valve 3, and outputs an ignition signal to an ignition plug 4 (power transistor).

[0037] In the operation of said fuel-injection signal, a target air-fuel ratio is determined according to a service condition, and although fuel oil consumption (injection pulse width) calculates so that the gaseous mixture of this target air-fuel ratio may be formed, it has the composition that the air-fuel ratio which is Lean is set up from theoretical air fuel ratio as said target air-fuel ratio. As said various sensors The air flow meter 7 which detects an engine's 1 intake air flow, the throttle sensor 8 which detects the opening of said throttle valve 2, the 1st air-fuel ratio sensor 10 (the 1st air-fuel ratio detection means) which is arranged in the flueway 9 of the upstream of said NOx absorption catalyst 5, and detects an exhaust air air-fuel ratio, The 2nd air-fuel ratio sensor 11 (the 2nd air-fuel ratio detection means) which is arranged in the flueway 9 of the downstream of said NOx absorption catalyst 5, and detects an exhaust air air-fuel ratio is formed, and also A rotation signal from a crank angle sensor, a water temperature signal from a coolant temperature sensor, etc. which are not illustrated are inputted into a control unit 6.

[0038] It may be the sensor which detects an exhaust air air-fuel ratio based on the oxygen density under exhaust air, and said 1st air-fuel ratio sensor 10 and the 2nd air-fuel ratio sensor 11 may be SUTOIKI sensors which detect only theoretical air fuel ratio, and may be a broader-based air-fuel ratio sensor which can detect an exhaust air air-fuel ratio in a wide area. Said control unit 6 sets up the air-fuel ratio feedback correction factor (control input) alpha for amending said fuel oil consumption by proportional-plus-integral control etc. so that the exhaust air air-fuel ratio detected by said 1st air-fuel ratio sensor 10 may usually be brought close to a target air-fuel ratio. The above-mentioned function is equivalent to the 1st air-fuel ratio feedback means.

[0039] The signs of control that a target air-fuel ratio uses said 2nd air-fuel ratio sensor 11 instead of said 1st air-fuel ratio sensor 10 theoretical air fuel ratio or immediately after switching richly from Lean, performs said feedback control of air-fuel ratio, and is equivalent to this 2nd air-fuel ratio feedback means on the other hand are shown in the flow chart of drawing 3 . It sets to the flow chart of drawing 3 R> 3, and is step 1 (all over drawing, it is described as S1.) first. The existence of formation of said start condition is judged by distinguishing the flag FRS which shows formation of the start condition of NOx processing Air Fuel Ratio Control by it being the same as that of the following.

[0040] Said NOx absorption catalyst 5 absorbs NOx under exhaust air when an exhaust air air-fuel ratio is Lean. Since an exhaust air air-fuel ratio emits said absorbed NOx theoretical air fuel ratio or when rich, a target air-fuel ratio from Lean, theoretical air fuel ratio or when it is switched richly Since NOx absorbed during the Lean combustion will be emitted, 1 is set to said flag FRS and formation of a start condition is distinguished.

[0041] In addition, the switch to theoretical air fuel ratio or Rich from Lean of a target air-fuel ratio Even if it is carried out by the service condition (change of acceleration, and a load and rotation) and also is under the condition to which the Lean air-fuel ratio is originally set as a target air-fuel ratio When it is presumed that the NOx absorbed amount in the NOx absorption catalyst 5 has reached the critical mass, it is a setup to which rich control is carried out temporarily, and the switch to temporary rich control for this NOx processing is also included.

[0042] If the switch to theoretical air fuel ratio or Rich from Lean of a target air-fuel ratio is performed and 1 is set to said flag FRS, it will progress to step 2 and a setup which switches the air-fuel ratio sensor used for feedback control of air-fuel ratio from the 1st air-fuel ratio sensor 10 till then to the 2nd air-fuel ratio sensor 11 will be performed. Feedback control of air-fuel ratio for this to bring the exhaust air air-fuel ratio detected by the 2nd air-fuel ratio sensor 11 close to the target air-fuel ratio after a switch is performed.

[0043] And at step 3, the exhaust air air-fuel ratio of the NOx absorption catalyst 5 downstream detected by said 2nd air-fuel ratio sensor 11 distinguishes whether it was richly reversed from Lean. In addition, when using the sensor which can detect an air-fuel ratio in a wide area as the 2nd air-fuel ratio sensor 11, it is good also as whether the judgment in said step 3 was reached to the target air-fuel ratio. If it is distinguished that the air-fuel ratio of the downstream of the NOx absorption catalyst 5 was richly reversed at step 3, it will progress to step 4 and said flag FRS will be reset to

zero, and at the following step 5, a setup which returns the air-fuel ratio sensor used for feedback control of air-fuel ratio from the 2nd air-fuel ratio sensor 11 to the 1st air-fuel ratio sensor 10 is performed.
[0044] The property of control of having followed the flow chart of above-mentioned drawing 3 is shown in the timing diagram of drawing 4 . In addition, the timing diagram of drawing 4 is the case where a SUTOIKI sensor is used as an air-fuel ratio sensor, and has shown the case where a target air-fuel ratio is switched to theoretical air fuel ratio (SUTOIKI) by the service condition from Lean. If 1 is set to said flag FRS, the air-fuel ratio sensor used for feedback control of air-fuel ratio will be switched to the 2nd air-fuel ratio sensor 11 from the 1st air-fuel ratio sensor 10 (if a target air-fuel ratio is switched to SUTOIKI from Lean), and the feedback control of air-fuel ratio using the 2nd air-fuel ratio sensor 11 will be started.
[0045] Although the exhaust air air-fuel ratio of the NOx absorption catalyst 5 upstream detected by the 1st air-fuel ratio sensor 10 is richly reversed comparatively early at this time Rich reversal of the 2nd air-fuel ratio sensor 11 is NOx and O2 in the NOx absorption catalyst 5. In order to be behind with desorption Even if the exhaust air air-fuel ratio detected by the 1st air-fuel ratio sensor 10 is richly reversed Furthermore, the quantity of fuel oil consumption will be increased gradually, a rich spike will be given, and rich reversal of the 2nd air-fuel ratio sensor 11 will bring forward rich reversal of the 2nd air-fuel ratio sensor 11 (inside of the NOx absorption catalyst 5) as a result.
[0046] Since it is effective in NOx processing in said NOx absorption catalyst 5 to give a rich spike, if the inside of the NOx absorption catalyst 5 is promptly made to a rich ambient atmosphere as mentioned above, the reduction processing of NOx can be carried out efficiently. Moreover, by advancing rich-ization on the basis of rich reversal of the 2nd air-fuel ratio sensor 11, even if there is change of an NOx absorbed amount or the amount of oxygen storage by degradation with the passage of time, it can control that the discharge of HC and CO increases by superfluous rich-ization.

[0047] And if the exhaust air air-fuel ratio detected by the 2nd air-fuel ratio sensor 11 is richly reversed from Lean, the feedback control of air-fuel ratio (the 2nd air-fuel ratio feedback means) using the 2nd air-fuel ratio sensor 11 will be suspended at the time, and the feedback control of air-fuel ratio (the 1st air-fuel ratio feedback means) which used the 1st air-fuel ratio sensor 10 will be started instead, and it will be fed back so that the exhaust air air-fuel ratio of the NOx absorption catalyst 5 upstream may be brought close to theoretical air fuel ratio.
[0048] The flow chart of drawing 5 shows the more detailed contents of processing as the base for the fundamental contents of control shown in the flow chart of said drawing 3 , and it explains the flow chart of said drawing 5 hereafter, referring to the timing diagram of said drawing 4 and drawing 6 . At step 11, if said flag FRS is distinguished and 1 is set to said flag FRS, it will progress to step 12.
[0049] At step 12, the air-fuel ratio sensor used for feedback control of air-fuel ratio is switched to the 2nd air-fuel ratio sensor 11 from the 1st air-fuel ratio sensor 10. At step 13, zero reset of the timer Talpha for measuring the time amount of Air Fuel Ratio Control which used the 2nd air-fuel ratio sensor 11 is carried out, and initial value (100 %) is reset to the air-fuel ratio feedback correction factor alpha (control input for amending fuel oil consumption).
[0050] At step 14, only rich part KNalpha+ study value LNalpha carries out increase change of the air-fuel ratio feedback correction factor alpha in step uniformly from said initial value (refer to drawing 6). Said uniform rich part KNalpha is a fixed value, and said study value LNalpha is the value which learned the correction factor alpha at the time of the detection result of said 2nd air-fuel ratio sensor 11 being richly reversed, and is explained in full detail behind.
[0051] Maximum Talphamax to which said timer Talpha was counted up at step 15, and said timer Talpha was beforehand set at the following step 16 It distinguishes whether it is the following (refer to drawing 6). Said timer Talpha is Maximum Talphamax. If it is the following, it will progress to step 17 and the increase correction of said correction factor alpha will be made by Integral alpha.
[0052] For the correction factor alpha which increased by said integral control, it is compared with maximum alphamax (refer to drawing 6) beforehand set up at the following step 18, and a correction factor alpha is maximum alphamax. When it is above, it progresses to step 19 and is maximum alphamax to a correction factor alpha. With setting, a correction factor alpha is maximum alphamax.

It avoids exceeding. It prevents that this becomes a superfluous rich spike.
[0053] In addition, it is good also as a configuration which waits for the air-fuel ratio which omits the integral control in said step 17, is made to hold as it is after only said uniform rich part KNalpha+ study value LNalpha has carried out increase change of the air-fuel ratio feedback correction factor alpha in step, and is detected by the 2nd air-fuel ratio sensor 11 to be richly reversed. At step 20, it distinguishes whether the output of the 2nd air-fuel ratio sensor 11 was richly reversed. And although it is made to usually return to control (the 1st air-fuel ratio feedback means) as what was able to give the expected rich spike when richly reversed, it progresses to step 21 first and said timer Talpha is the minimum value Talphamin. It distinguishes whether it is the following.
[0054] Timer Talpha is the minimum value Talphamin. After exceeding, when rich reversal is carried out, it progresses to step 22 and the updating operation of said study value LNalpha is performed according to a bottom type (one formula). The part of this step 22 is equivalent to a study means.
By the LNalpha=(n-1) (xLNalpha(old things) +alpha')/n top formula, LNalpha (old things) is a study value before updating, and alpha' shows the correction factor alpha when being richly reversed. And study value LNalpha before updating (old things) and correction factor alpha' at the time of rich reversal are equalized by weighting-factor n set up beforehand, and the updating storage of the value after this equalization is carried out as new study value LNalpha.
[0055] Thereby, the optimal value required of reversing richly the output of the 2nd air-fuel ratio sensor 11 can be given as step variation immediately after switching to the 2nd air-fuel ratio sensor 11. In addition, said study value LNalpha is calculated for every loads at the time of rich reversal, and rotation conditions, and you may make it make it memorize.
[0056] Moreover, said timer Talpha is Maximum Talphamax at said step 16. Also when it is distinguished that it is above, it progresses to step 22 and study value LNalpha is made to update according to an upper type. In this case, for said correction factor alpha', said timer Talpha is Maximum Talphamax. It gives as a final value at the time of becoming. As mentioned above, said timer Talpha is Maximum Talphamax. When it becomes above, without waiting for rich reversal, it prevents that rich control is continued superfluously by making it usually return to control compulsorily, and the processing which progresses to step 22 from the step step 16 is equivalent to a forcible stop means.
[0057] On the other hand, timer Talpha is the minimum value Talphamin at step 21. When [at which rich reversal was carried out in the condition of the following] judged, it progresses to step 23 and the updating operation of said study value LNalpha is performed according to a bottom type (two formulas). The part of this step 23 is equivalent to a study value reduction correction means.
LNalpha=DNalphaxLNalpha (old things)
multiplier (DNalpha<1) for said DNalpha to make the reduction correction of the study value LNalpha it is -- the time amount which rich reversal takes by the time amount which rich reversal took making the reduction correction of the study value LNalpha in being unusually short -- the minimum value Talphamin It is made to exceed and is made to carry out rich reversal by responsibility proper to NOx processing.
[0058] At step 24, it is initial value (100 %) (zero reset of said flag FRS is carried out, further, the air-fuel ratio sensor used for feedback control of air-fuel ratio is returned to the 1st air-fuel ratio sensor 10 from the 2nd air-fuel ratio sensor 11, and the usual feedback control of air-fuel ratio (the 1st air-fuel ratio feedback means) is made to return and to be performed after that in step 26 at the following step 25 based on the detection result of the 1st air-fuel ratio sensor 10.) about said correction factor alpha.
[0059] By the way, although the inside of the NOx absorption catalyst 5 can be controlled by performing feedback control of air-fuel ratio which used the 2nd air-fuel ratio sensor 11 at an early stage in an air-fuel ratio ambient atmosphere proper to NOx processing when processing NOx absorbed by the NOx absorption catalyst 5 during the Lean combustion as mentioned above, NOx may be discharged by the above-mentioned control at the downstream of the NOx absorption catalyst 5, or HC and CO may be discharged by rich spike.
[0060] Then, it is good to constitute so that NOx, HC, and CO which are shown in drawing 7 and which have arranged the three way component catalyst 12 to the downstream of said NOx absorption

catalyst 5, and were not able to be purified with the NOx absorption catalyst 5 like the gestalt of the 2nd operation may be processed with said three way component catalyst 12. Furthermore, in order to make it process efficiently with said three way component catalyst 12, it is good to make Air Fuel Ratio Control perform, as it is shown in the flow chart of drawing 8 .
[0061] In the flow chart of drawing 8 , if the completely same processing as step 11 of the flow chart of above-mentioned drawing 5 - step 20 is performed and 1 is set to said flag FRS, it will carry out increase control of the air-fuel ratio feedback correction factor alpha by integral control until the output of the 2nd air-fuel ratio sensor 11 will carry out rich reversal of each step from step 31 to step 40 (if a target air-fuel ratio is switched to theoretical air fuel ratio or Rich from Lean).
[0062] And the holding time NRT which makes said air-fuel ratio feedback correction factor alpha hold at step 40 with reference to the table TNRT which memorized the holding time NRT beforehand at the following step 41 according to the Lean control time amount, i.e., the duration of the Air Fuel Ratio Control condition which makes a target air-fuel ratio Lean, when it was distinguished that the output of the 2nd air-fuel ratio sensor 11 carried out rich reversal is determined. Here, as shown in drawing 9 , the time when said Lean time amount is longer sets up said holding time TNRT for a long time.
[0063] At step 42, it is made only for said holding time NRT to make the air-fuel ratio feedback correction factor alpha at the time of the output of the 2nd air-fuel ratio sensor 11 carrying out rich reversal hold (refer to drawing 10), and after said holding time NRT passes, it progresses to step 43. The part of the above-mentioned steps 41 and 42 is equivalent to the rich control input maintenance means by time amount. After each step of steps 43-48 performs the same processing as steps 21-26 of the flow chart of said drawing 5 and performs the updating operation of study value LNalpha, it is returned to the usual feedback control of air-fuel ratio (the 1st air-fuel ratio feedback means) by the 1st air-fuel ratio sensor 10.
[0064] As mentioned above, also after the inside of the NOx absorption catalyst 5 becomes a rich ambient atmosphere, the inside of a three way component catalyst 12 can be made into a rich ambient atmosphere at an early stage, and NOx discharged without being purified with the NOx absorption catalyst 5 can be made to purify efficiently because only the holding time NRT makes the air-fuel ratio feedback correction factor alpha at that time hold. As that from which the time amount taken for the inside of a three way component catalyst 12 to carry out rich reversal according to the Lean time amount changes with the gestalt of operation shown in the flow chart of above-mentioned drawing 8 , although it was made only for the holding time NRT according to the Lean time amount to make the air-fuel ratio feedback correction factor alpha hold Like [in order to control the air-fuel ratio in a three way component catalyst 12 the more nearly optimal] the gestalt of the 3rd operation shown in drawing 11 The 3rd air-fuel ratio sensor 13 (the 3rd air-fuel ratio detection means) is arranged to the downstream of a three way component catalyst 12, and you may make it make the period which makes the air-fuel ratio feedback correction factor alpha hold based on the detection result of this 3rd air-fuel ratio sensor 13 control.
[0065] In addition, said 3rd air-fuel ratio sensors 13 may also be any of a SUTOIKI sensor or a broader-based air-fuel ratio sensor. The situation of control using said 3rd air-fuel ratio sensor 13 is shown in the flow chart of drawing 12. In the flow chart of drawing 12, if the completely same processing as step 11 of the flow chart of above-mentioned drawing 5 - step 20 is performed and 1 is set to said flag FRS, it will carry out increase control of the air-fuel ratio feedback correction factor alpha by integral control until the output of the 2nd air-fuel ratio sensor 11 carries out rich reversal of each step from step 51 to step 60.
[0066] And at step 61, a setup which makes the air-fuel ratio feedback correction factor alpha at the time of the 2nd air-fuel ratio sensor 11 carrying out rich reversal hold is performed, and it distinguishes whether the output of said 3rd air-fuel ratio sensor 13 carried out rich reversal in the following step 62. When it returns to step 61, the maintenance condition of the air-fuel ratio feedback correction factor alpha is maintained and the 3rd air-fuel ratio sensor 13 carries out rich reversal at step 62 until rich reversal of the 3rd air-fuel ratio sensor 13 is distinguished, it progresses to step 63 (refer to drawing 13).
[0067] The part of the above-mentioned steps 61 and 62 is equivalent to a rich control input maintenance means. After each step of steps 63-68 performs the same processing as steps 21-26 of

the flow chart of said drawing 5 and performs the updating operation of study value LNalpha, it is returned to the usual feedback control of air-fuel ratio by the 1st air-fuel ratio sensor 10. As mentioned above, if it is the configuration of making the air-fuel ratio feedback correction factor alpha holding until the 3rd air-fuel ratio sensor 13 carries out rich reversal, the holding time can be controlled the optimal and the holding time is insufficient, and a three way component catalyst 12 cannot purify NOx efficiently, or it can avoid that the holding time will be too long and a superfluous rich spike will be given conversely.

[Translation done.]

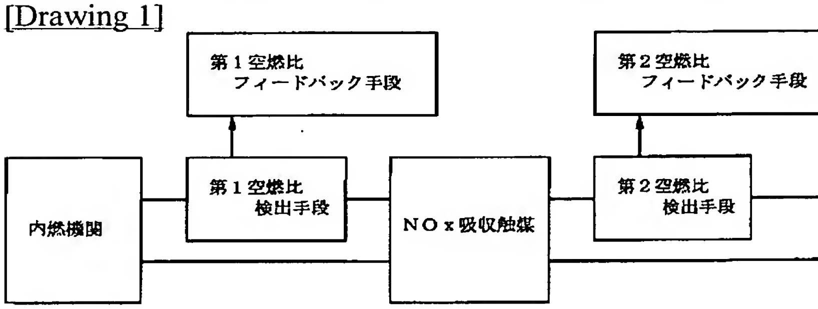
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram showing the basic configuration of the exhaust emission control device concerning invention according to claim 1.
[Drawing 2] An internal combustion engine's system configuration Fig. in the gestalt of the 1st operation.
[Drawing 3] The flow chart which shows the situation of fundamental Air Fuel Ratio Control in the gestalt of the 1st operation.
[Drawing 4] The timing diagram which shows the property of Air Fuel Ratio Control in the gestalt of the 1st operation.
[Drawing 5] The flow chart which shows a detail for Air Fuel Ratio Control in the gestalt of the 1st operation.
[Drawing 6] The timing diagram which shows the property of the air-fuel ratio feedback correction factor in the gestalt of the 1st operation.
[Drawing 7] An internal combustion engine's system configuration Fig. in the gestalt of the 2nd operation.
[Drawing 8] The flow chart which shows the detail of Air Fuel Ratio Control in the gestalt of the 2nd operation.
[Drawing 9] The diagram showing correlation with the holding time NRT and the Lean time amount in the gestalt of the 2nd operation.
[Drawing 10] The timing diagram which shows the property of Air Fuel Ratio Control in the gestalt of the 2nd operation.
[Drawing 11] An internal combustion engine's system configuration Fig. in the gestalt of the 3rd operation.
[Drawing 12] The flow chart which shows the detail of Air Fuel Ratio Control in the gestalt of the 3rd operation.
[Drawing 13] The timing diagram which shows the property of Air Fuel Ratio Control in the gestalt of the 2nd operation.
[Drawing 14] The timing diagram for explaining the trouble of control conventionally.
[Description of Notations]
1 Internal Combustion Engine
2 Throttle Valve
3 Fuel Injection Valve
4 Ignition Plug
5 NOx Absorption Catalyst
6 Control Unit
7 Air Flow Meter
8 Throttle Sensor
9 Flueway
10 1st Air-fuel Ratio Sensor
11 2nd Air-fuel Ratio Sensor
12 Three Way Component Catalyst
13 3rd Air-fuel Ratio Sensor

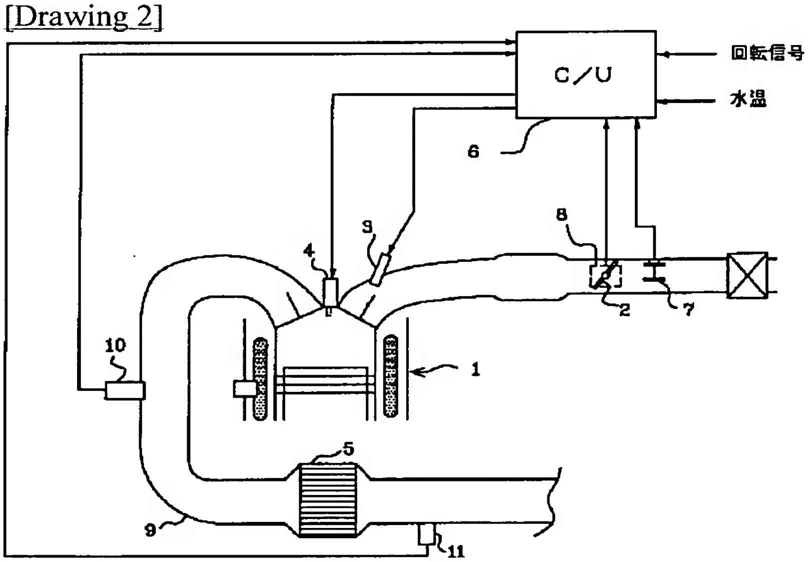
[Translation done.]

DRAWINGS

[Drawing 1]



[Drawing 2]



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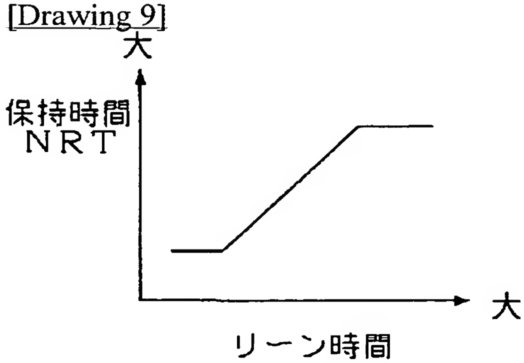

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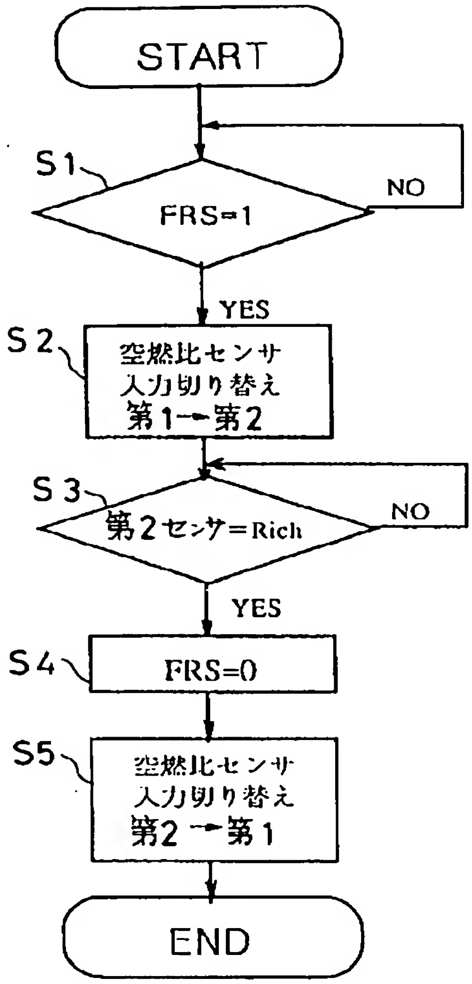

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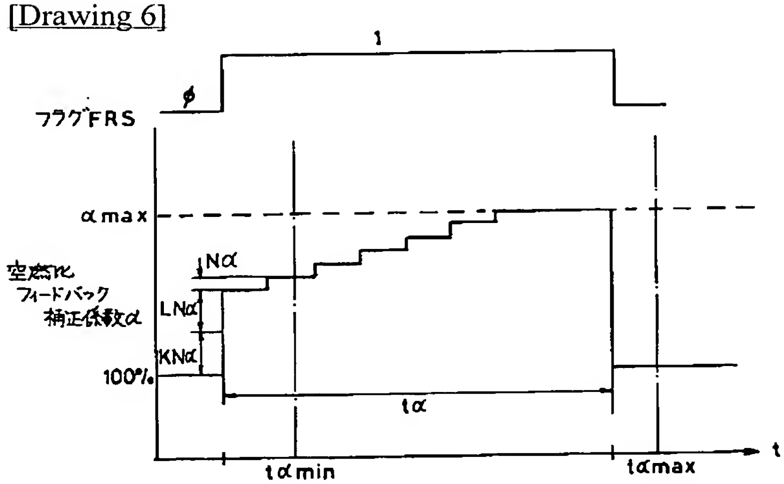
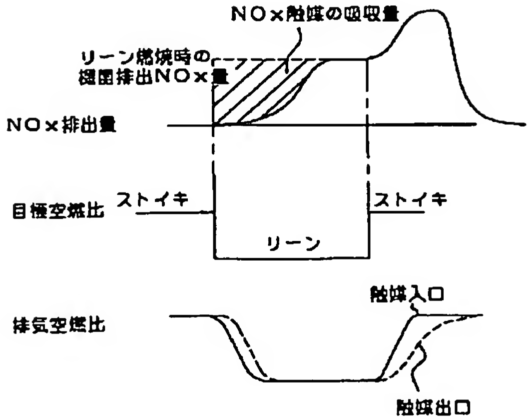


[Drawing 14]



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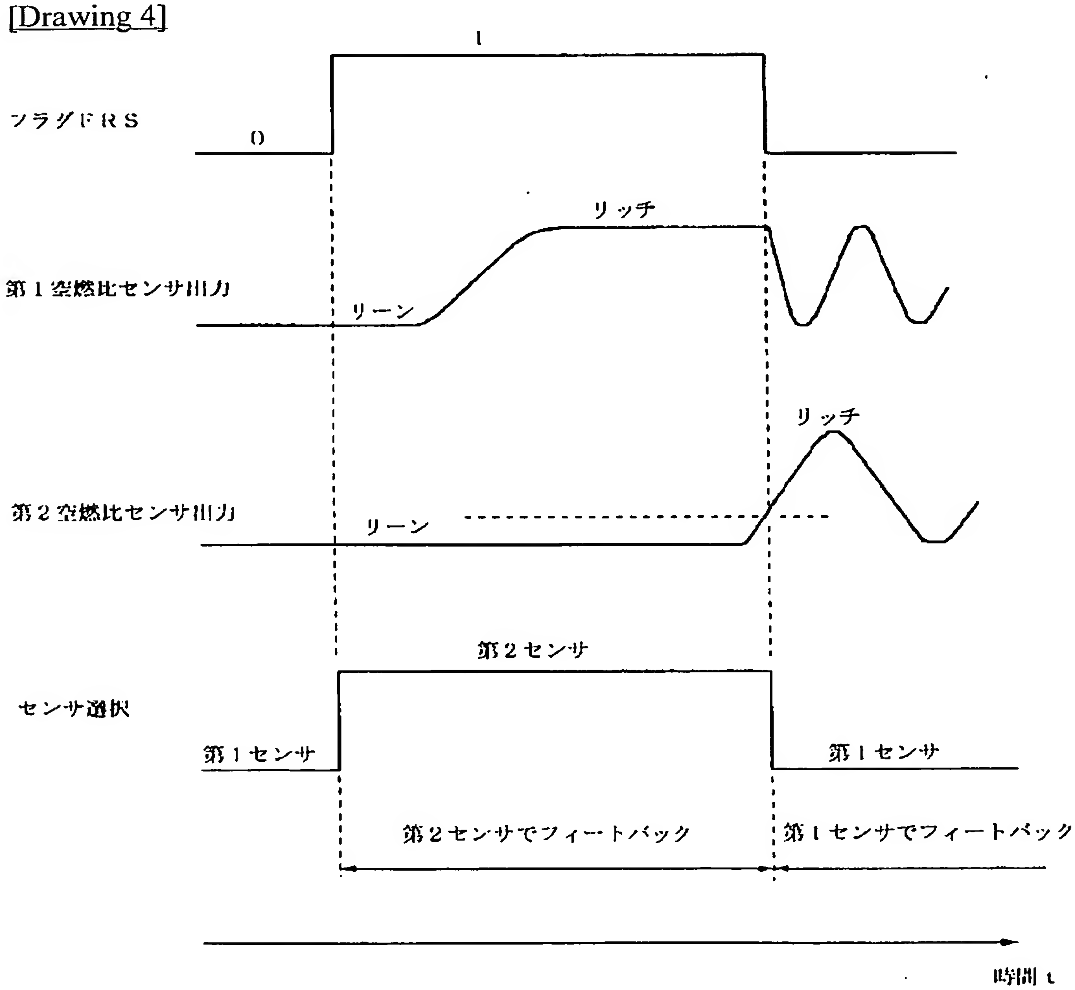

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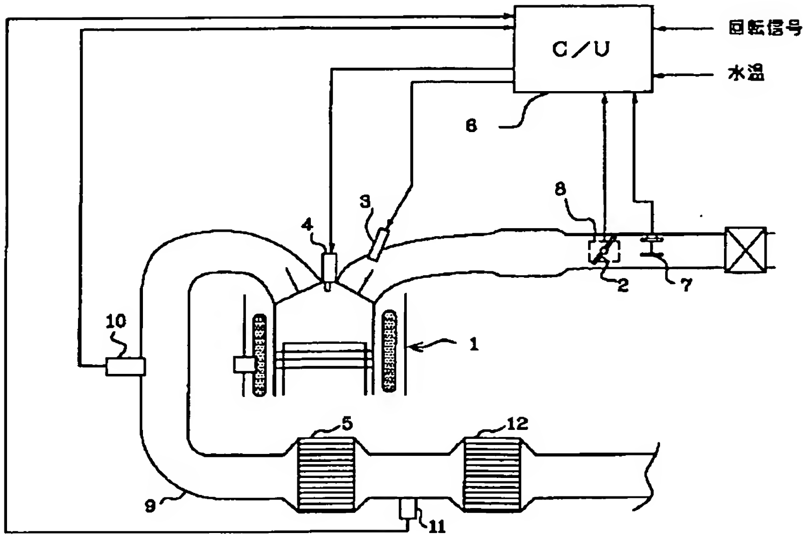

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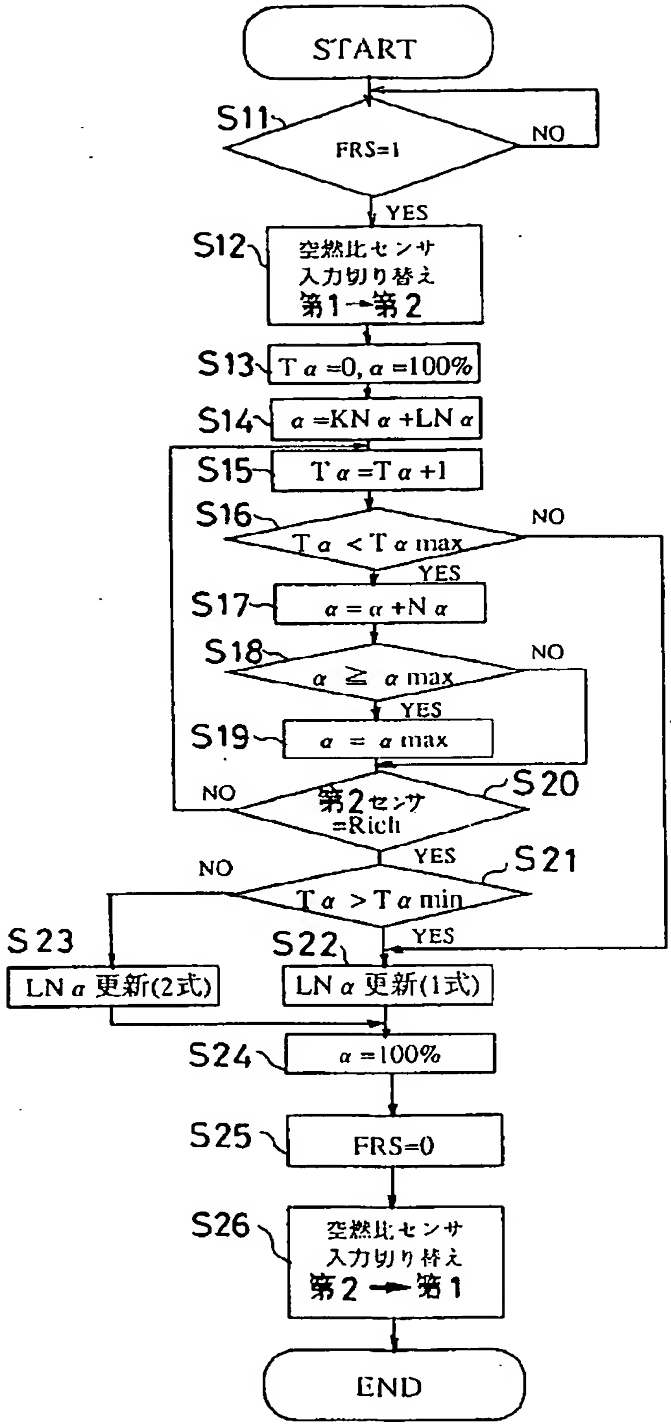
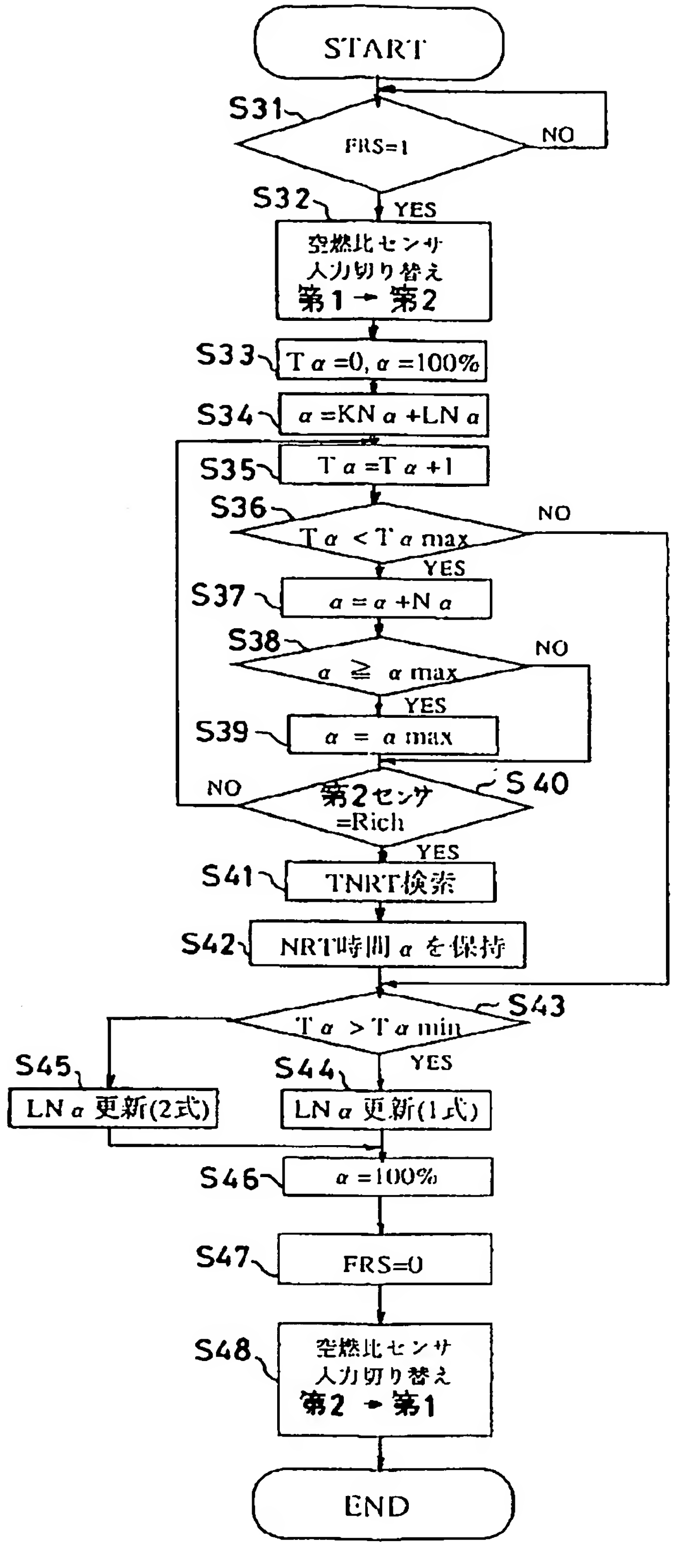
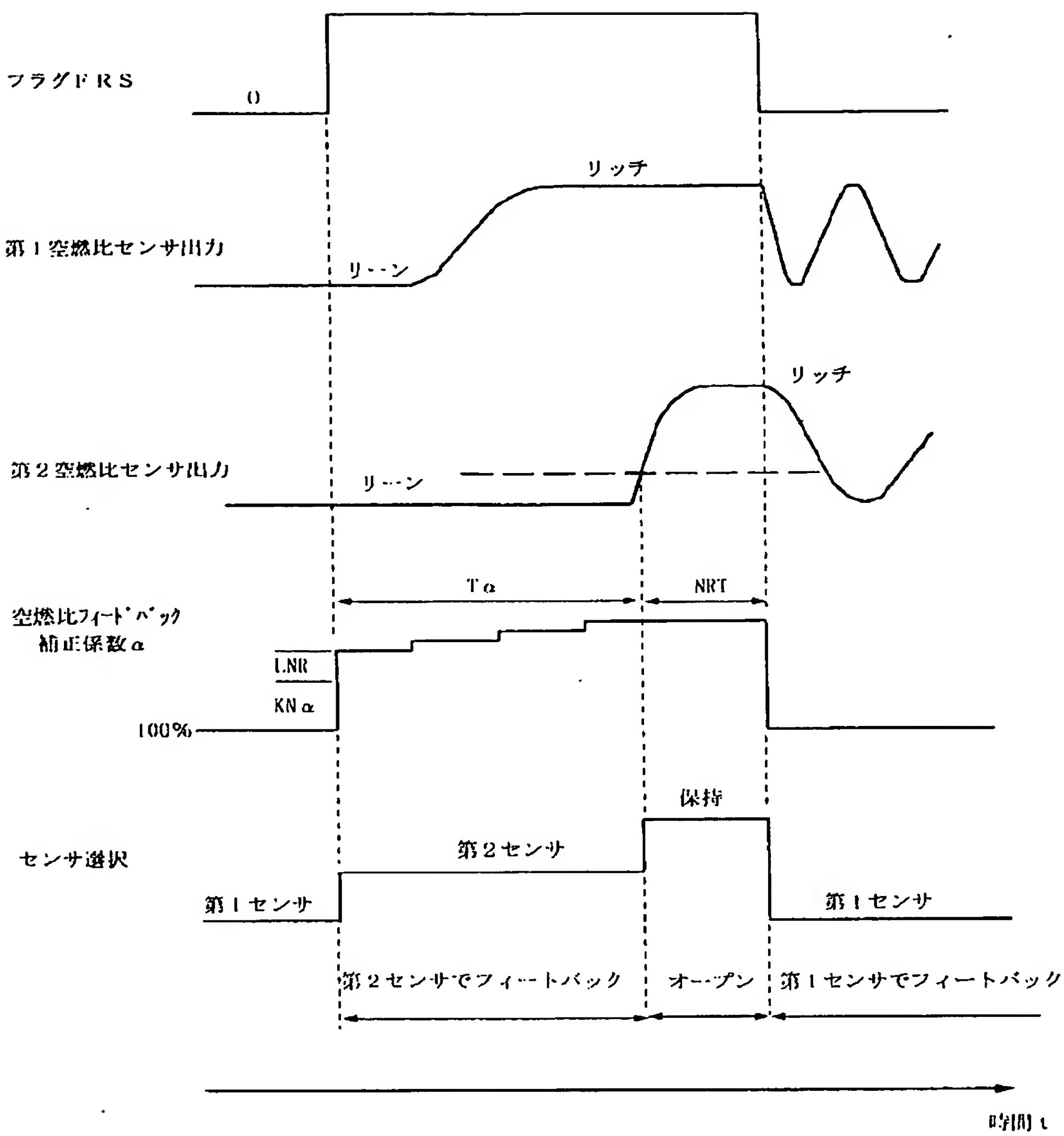

START
S11
FRS=1
NO
YES
S12
空燃比センサ
入力切り替え
第1→第2
S13
Tα=0, α=100%
S14
α=KNα+LNα
S15
Tα=Tα+1
S16
Tα<Tαmax
NO
YES
S17
α=α+Nα
S18
α≧αmax
NO
YES
S19
α=αmax
S20
第2センサ
=Rich
NO
YES
S21
Tα>Tαmin
NO
YES
S23
LNα更新(2式)
S22
LNα更新(1式)
S24
α=100%
S25
FRS=0
S26
空燃比センサ
入力切り替え
第2→第1
END

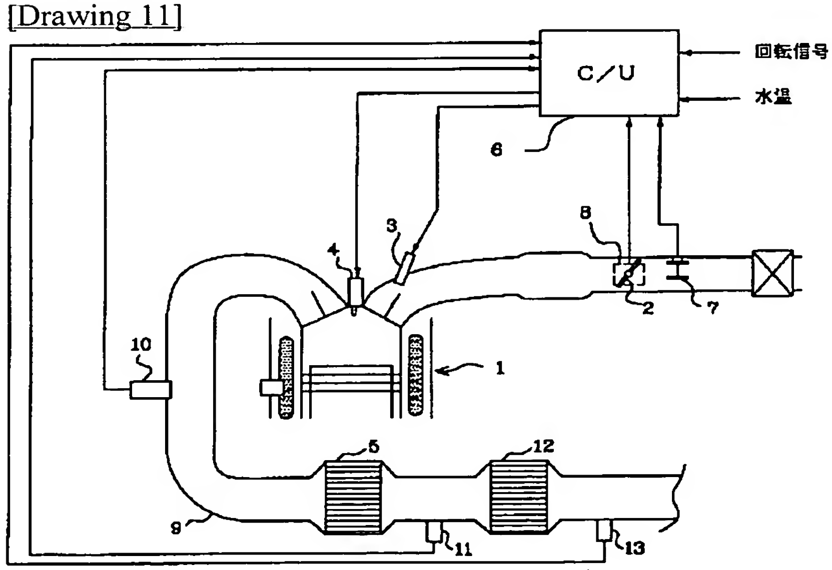
[Drawing 8]


START
S31
FRS=1
NO
S32
YES
空燃比センサ
入力切り替え
第1 → 第2
S33
Tα=0, α=100%
S34
α=KNα+LNα
S35
Tα=Tα+1
S36
Tα < Tα max
NO
YES
S37
α=α+Nα
S38
α ≧ α max
NO
YES
S39
α = α max
NO
第2センサ
=Rich
S40
YES
S41
TNRT検索
S42
NRT時間αを保持
S43
Tα > Tα min
S45
S44
YES
LNα更新(2式)
LNα更新(1式)
S46
α=100%
S47
FRS=0
S48
空燃比センサ
入力切り替え
第2 → 第1
END

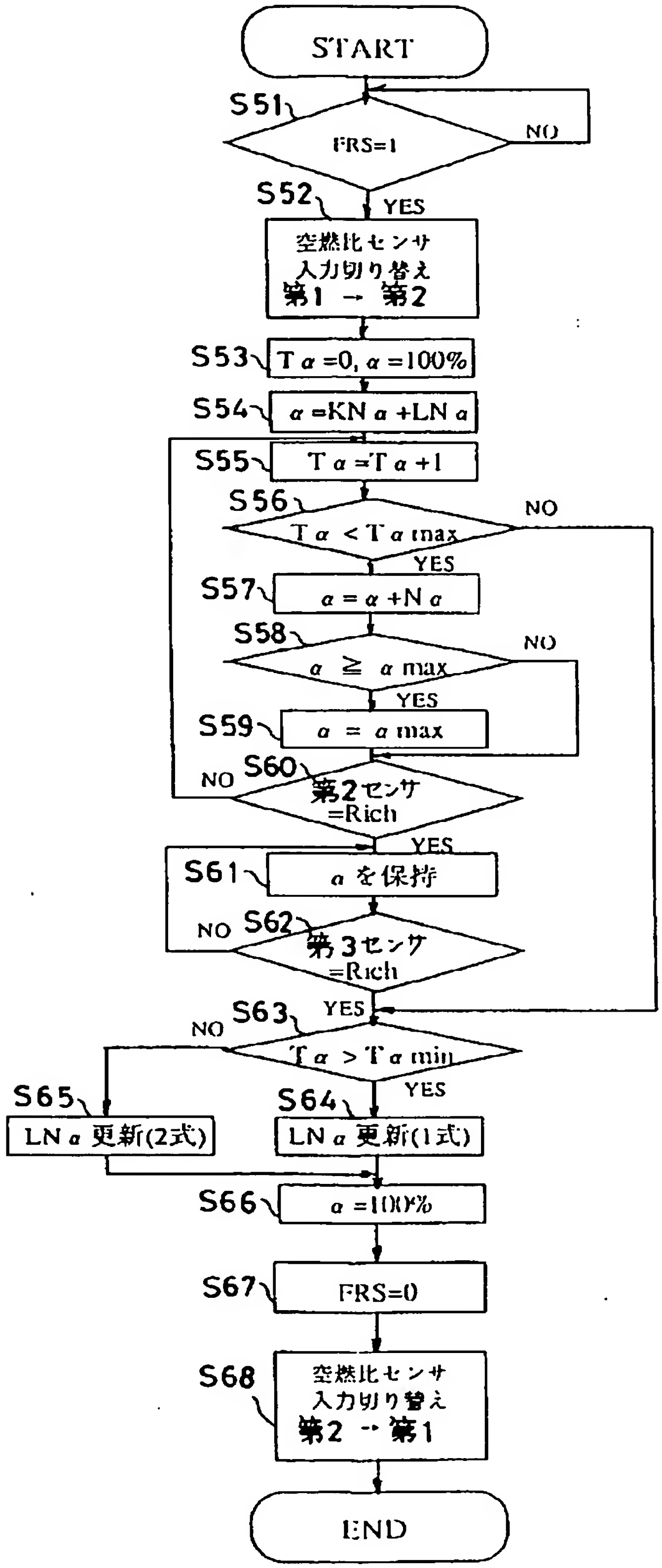
[Drawing 10]



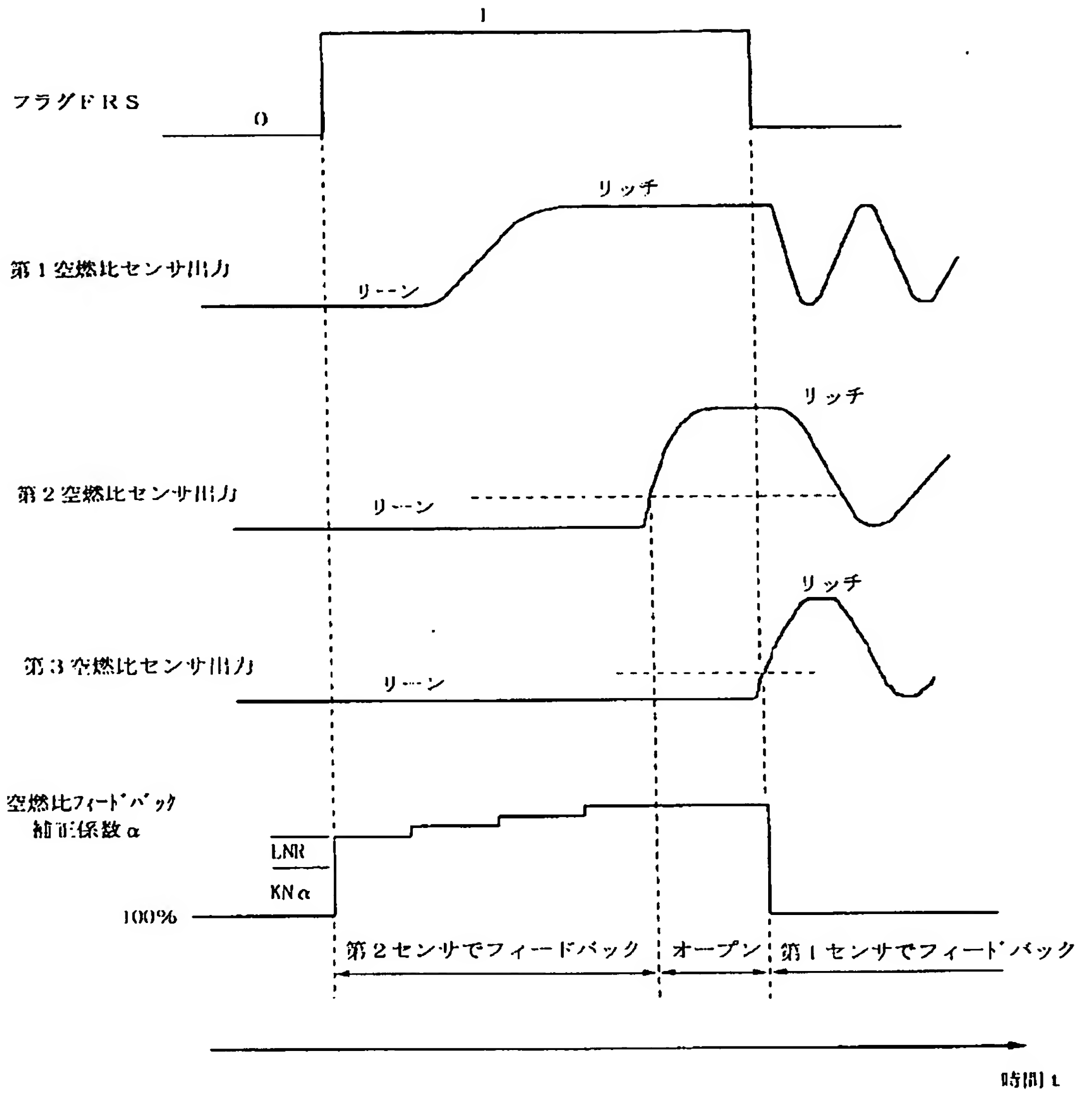
[Drawing 11]



[Drawing 12]


START
S51
FRS=1
NO
S52
YES
空燃比センサ
入力切り替え
第1 → 第2
S53
Tα=0, α=100%
S54
α=KNα+LNα
S55
Tα=Tα+1
S56
Tα < Tαmax
NO
YES
S57
α=α+Nα
S58
α ≧ αmax
NO
YES
S59
α = αmax
S60
第2センサ
=Rich
NO
YES
S61
αを保持
S62
第3センサ
=Rich
NO
YES
S63
Tα > Tαmin
NO
YES
S65
LNα 更新(2式)
S64
LNα 更新(1式)
S66
α=100%
S67
FRS=0
S68
空燃比センサ
入力切り替え
第2 → 第1
END

[Drawing 13]



[Translation done.]

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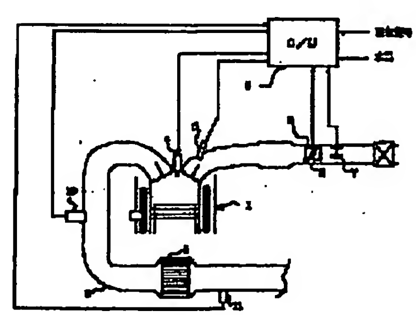
(54) EXHAUST EMISSION CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE

(57) Abstract

PROBLEM TO BE SOLVED: To restrain exhaust of HC and CO while efficiently purifying NOx by controlling the air-fuel mixture air-fuel ratio by making a feedback process to reverse the downstream side exhaust air-fuel ratio of an NOx absorbing catalyst to rich just after the target air-fuel ratio of an air-fuel mixture is switched to the theoretical air-fuel ratio or rich from lean.

SOLUTION: Air-fuel ratio sensors 10 and 11 are respectively arranged on the upstream-downstream sides of an NOx absorbing catalyst 5 of an exhaust system, and just after the target air-fuel ratio of an air-fuel mixture is switched to the theoretical air-fuel ratio or rich from lean, by an ECU 6, air-fuel ratio feedback control is performed by using the downstream side sensor 11 instead of the upstream side sensor 10. At this time, since reversal to rich of the downstream side sensor 11 delays by removal of NOx and O_2 in the catalyst 5, even if the exhaust air-fuel ratio detected by the upstream side sensor 10 reverses to rich, a fuel injection quantity is controlled so as to be gradually increased until the downstream side sensor 11 reverses to rich further, and reversal to rich of the downstream side sensor 11 is quickened.



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			310F
			310H
	ZAB		ZAB
F01N　3/08	ZAB	F01N　3/08	ZABA

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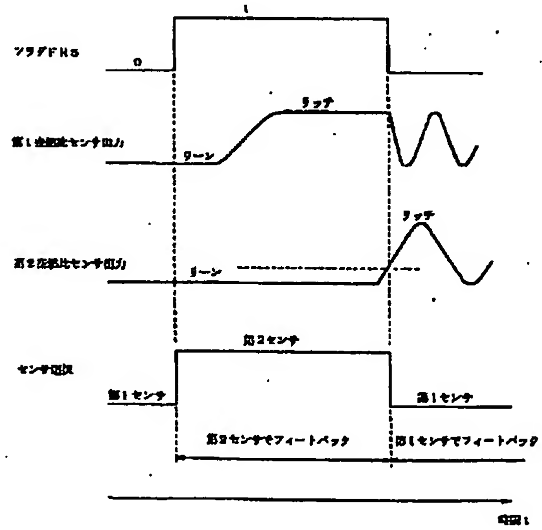
(54)【発明の名称】　内燃機関の排気浄化装置

(57)【要約】

【課題】NOx吸収触媒に吸収されたNOxを、効率良く、かつ、HC，COの排出量を増大させることなく浄化する。

【解決手段】目標空燃比がリーンから理論空燃比又はリッチに切り換えられたときに、NOx処理のための空燃比制御条件の成立を判断し、フラグFRSに1をセットする。前記フラグFRSに1がセットされると、空燃比フィードバック制御に用いる空燃比センサを、通常の触媒上流側に設けられる第1センサから、触媒下流側に設けられる第2センサに切り換えて、この第2センサで検出される空燃比に基づいてフィードバック制御を実行させる。そして、第2センサで検出される排気空燃比がリッチに反転すると、前記フラグFRSをゼロリットし、空燃比フィードバック制御に用いる空燃比センサを通常の第1センサに戻す。



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【特許請求の範囲】

【請求項１】排気空燃比がリーンであるときに排気中のＮＯｘを吸収し、排気空燃比が理論空燃比又はリッチであるときに前記吸収したＮＯｘを放出して還元処理するＮＯｘ吸収触媒を備える一方、
燃焼混合気の目標空燃比がリーンから理論空燃比又はリッチに切り換えられた直後において、前記ＮＯｘ吸収触媒の下流側の排気空燃比をリッチに反転させるべく、燃焼混合気の空燃比をフィードバック制御することを特徴とする内燃機関の排気浄化装置。

【請求項２】前記ＮＯｘ吸収触媒の下流側に三元触媒を備え、前記ＮＯｘ吸収触媒の下流側の排気空燃比がリッチに反転したときのフィードバック操作量を、前記リッチに反転した時点から前記三元触媒の下流側の排気空燃比がリッチに反転するまでの間保持させることを特徴とする請求項１記載の内燃機関の排気浄化装置。

【請求項３】前記ＮＯｘ吸収触媒の下流側に三元触媒を備え、前記ＮＯｘ吸収触媒の下流側の排気空燃比がリッチに反転したときのフィードバック操作量を、前記リッチに反転した時点から所定時間保持させることを特徴とする請求項１記載の内燃機関の排気浄化装置。

【請求項４】排気空燃比がリーンであるときに排気中のＮＯｘを吸収し、排気空燃比が理論空燃比又はリッチであるときに前記吸収したＮＯｘを放出して還元処理するＮＯｘ吸収触媒と、
該ＮＯｘ吸収触媒の上流側で排気空燃比を検出する第１空燃比検出手段と、
前記ＮＯｘ吸収触媒の下流側で排気空燃比を検出する第２空燃比検出手段と、
通常状態において、前記第１空燃比検出手段で検出される排気空燃比に基づいて燃焼混合気の空燃比を目標空燃比にフィードバック制御する第１空燃比フィードバック手段と、
燃焼混合気の目標空燃比がリーンから理論空燃比又はリッチに切り換えられた直後においてのみ、前記第２空燃比検出手段で検出される排気空燃比に基づいて燃焼混合気の空燃比を目標空燃比にフィードバック制御する第２空燃比フィードバック手段と、
を含んで構成されたことを特徴とする内燃機関の排気浄化装置。

【請求項５】前記第２空燃比フィードバック手段が、目標空燃比の切り換えから前記第２空燃比検出手段で検出される排気空燃比がリッチに反転するまで間においてフィードバック制御を行うことを特徴とする請求項４記載の内燃機関の排気浄化装置。

【請求項６】前記第２空燃比フィードバック手段による空燃比フィードバック制御により、所定の最大時間が経過してもリッチに反転しないときに、前記第２空燃比フィードバック手段による空燃比フィードバック制御を強制的に停止させる強制停止手段を備えたことを特徴とする請求項５記載の内燃機関の排気浄化装置。

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【請求項７】前記第２空燃比フィードバック手段による空燃比フィードバック制御によってリッチに反転したときの操作量を学習値として学習する学習手段を備え、前記第２空燃比フィードバック手段が、空燃比フィードバック制御の開始時に前記学習値だけ操作量をステップ変化させることを特徴とする請求項５又は６に記載の内燃機関の排気浄化装置。

【請求項８】前記第２空燃比フィードバック手段による空燃比フィードバック制御により、所定の最小時間以内でリッチに反転したときに、前記学習値を減少修正する学習値減少修正手段を設けたことを特徴とする請求項７記載の内燃機関の排気浄化装置。

【請求項９】前記ＮＯｘ吸収触媒の下流側に配置された三元触媒と、
該三元触媒の下流側で排気空燃比を検出する第３空燃比検出手段と、
前記第２空燃比検出手段で検出される排気空燃比がリッチに反転した時点における第２空燃比フィードバック制御手段による操作量を、前記第３空燃比検出手段で検出される排気空燃比がリッチに反転するまでの間保持させるリッチ操作量保持手段と、
を設けたことを特徴とする請求項５～８のいずれか１つに記載の内燃機関の排気浄化装置。

【請求項10】前記ＮＯｘ吸収触媒の下流側に配置された三元触媒と、
前記第２空燃比検出手段で検出される排気空燃比がリッチに反転した時点における第２空燃比フィードバック制御手段による操作量を、その後所定時間保持させる時間によるリッチ操作量保持手段と、
を設けたことを特徴とする請求項５～８のいずれか１つに記載の内燃機関の排気浄化装置。

【請求項11】前記時間によるリッチ操作量保持手段が、前記三元触媒がリーン雰囲気に晒されていた時間に応じて前記操作量を保持させる時間を変更することを特徴とする請求項10記載の内燃機関の排気浄化装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、内燃機関の排気浄化装置に関し、詳しくは、排気通路にＮＯｘ吸収触媒を備えた内燃機関において、ＮＯｘの浄化に必要な最適空燃比に制御するための技術に関する。

【０００２】

【従来の技術】従来から、排気空燃比がリーンであるときに排気中のＮＯｘを吸収し、排気空燃比が理論空燃比（ストイキ）又はリッチであるときに前記吸収したＮＯｘを放出して還元処理するＮＯｘ吸収触媒（ＮＯｘ吸収型三元触媒）を備えた機関が知られている（特開平７－１３９３９７号公報等参照）。

【０００３】

【発明が解決しようとする課題】前記NOx吸収触媒は、図14に示すように、リーン燃焼中においてNOxを吸収して大気中に排出されるNOx量を低減するが、吸収量が最大量を越えてしまうと、機関から排出されたNOxが触媒に吸収されずにそのまま大気中に排出されることになってしまう。

【0004】そこで、NOx吸収触媒におけるNOx吸収量が最大量に達していることが、負荷，回転，空燃比などに基づいて推定されると、目標空燃比を強制的に理論空燃比又はリッチに切り換えて、NOx吸収触媒に吸収されているNOxの放出，還元処理を行わせるようにしている。しかし、目標空燃比をリーンから理論空燃比又はリッチに切り換えても、NOx吸収触媒に吸収されていたNOxやO_2の脱離によって、触媒内がなかなかリッチ化しないため、NOxの還元に必要なHCやCOがリーン雰囲気において酸化されてしまい、NOxが効率良く浄化されずに排出されてしまうことになる（図14参照）。

【0005】従って、NOxを浄化させるときには、NOx吸収触媒内を速やかにリッチ化させることが要求され、そのためには、リッチスパイクを与えることが有効である。ところが、NOx吸収触媒が経時劣化すると、NOxの最大吸収量やO_2ストレージ能力が変化するため、新品状態のNOx吸収触媒に適合させて、前記リッチスパイク量を一律に設定すると、劣化時にリッチスパイクが過剰となってHC，COの排出量を増大させてしまうという問題があった。

【0006】また、最適なリッチスパイクを与えた場合であっても、浄化されずにNOx吸収触媒から排出されるNOxが発生することがあり、これは、リッチ量の増大によっては解消できず、過剰なリッチ制御は、前述のようにHC，COの排出量を増大させてしまうという問題を生じさせる。本発明は上記問題点に鑑みなされたものであり、NOx吸収触媒の経時劣化が生じても、NOx浄化に最適な空燃比に制御でき、以て、NOxを効率良く浄化しつつ、HC，COの排出を抑制できる排気浄化装置を提供することを目的とする。

【0007】また、NOx吸収触媒から還元されずに排出されるNOxがあっても、これを確実に処理して大気中への排出を抑止できる排気浄化装置を提供することを目的とする。

【0008】

【課題を解決するための手段】そのため請求項1記載の発明は、排気空燃比がリーンであるときに排気中のNOxを吸収し、排気空燃比が理論空燃比又はリッチであるときに前記吸収したNOxを放出して還元処理するNOx吸収触媒を備える一方、燃焼混合気の目標空燃比がリーンから理論空燃比又はリッチに切り換えられた直後において、前記NOx吸収触媒の下流側の排気空燃比をリッチに反転させるべく、燃焼混合気の空燃比をフィードバック制御する構成とした。

【0009】かかる構成によると、目標空燃比がリーンから理論空燃比又はリッチに切り換えられた直後、即ち、リーン燃焼中にNOx吸収触媒に吸収されたNOxの浄化が行われる条件のときに、NOx吸収触媒の下流側の排気空燃比をリーンからリッチに反転させるべく空燃比フィードバック制御が行われる。尚、前記目標空燃比の切り換えは、加速等の運転条件の変化による目標空燃比の切り換えの他、NOx吸収触媒に対するNOx吸収量が限界にきたために、一時的に目標空燃比が理論空燃比又はリッチに切り換えられる場合を含む。

【0010】NOx吸収触媒の出口側の排気空燃比、換言すれば、NOx吸収触媒内の雰囲気は、そのときのNOx吸収量や酸素ストレージ量などに影響されて入口側の変化に対して応答遅れをもって変化するから、たとえ入口側が目標に達していても出口側においては目標に達していないことがある。そこで、出口側の排気空燃比に基づいて空燃比フィードバック制御を行わせ、たとえ入口側が目標に達しても、出口側が目標に対するまでは空燃比を変化させることで、出口側（触媒内）の空燃比変化を早めることができる。

【0011】請求項2記載の発明では、前記NOx吸収触媒の下流側に三元触媒を備え、前記NOx吸収触媒の下流側の排気空燃比がリッチに反転したときのフィードバック操作量を、前記リッチに反転した時点から前記三元触媒の下流側の排気空燃比がリッチに反転するまでの間保持させる構成とした。かかる構成によると、NOx吸収触媒の下流側に更に三元触媒を配置される。そして、目標空燃比の切り換え後に前述の空燃比フィードバック制御によって、NOx吸収触媒の下流側がリッチに反転すると、そのときの空燃比の操作量（例えば燃料噴射量を補正するための補正係数）を、前記三元触媒の下流側がリッチに反転するまで保持させる。

【0012】即ち、前記三元触媒を設けることで、NOx吸収触媒で浄化できなかったNOxを前記三元触媒で浄化しようとするものであるが、前記三元触媒での浄化を効率良く行わせるべく、前記三元触媒内を速やかにリッチにする必要がある。そこで、NOx吸収触媒内をリッチに反転させた操作量にクランプさせることで、燃焼混合気の空燃比をリッチに保持し、三元触媒内がリッチに反転してから通常制御に移行させるようにする。

【0013】請求項3記載の発明では、前記NOx吸収触媒の下流側に三元触媒を備え、前記NOx吸収触媒の下流側の排気空燃比がリッチに反転したときのフィードバック操作量を、前記リッチに反転した時点から所定時間保持させる構成とした。かかる構成では、三元触媒の下流側の排気空燃比が、前記操作量のクランプを開始してから所定時間だけ経過したときにリッチに反転するものと推定し、前記所定時間経過後に通常制御に復帰させる。

【0014】一方、請求項4記載の発明は、図1に示すように構成される。図1において、NOx吸収触媒は、排気空燃比がリーンであるときに排気中のNOxを吸収し、排気空燃比が理論空燃比又はリッチであるときに前記吸収したNOxを放出して還元処理する触媒である。第1空燃比検出手段は、NOx吸収触媒の上流側で排気空燃比を検出し、第2空燃比検出手段は、NOx吸収触媒の下流側で排気空燃比を検出する。

【0015】第1空燃比フィードバック手段は、通常状態において、前記第1空燃比検出手段で検出される排気空燃比に基づいて燃焼混合気の空燃比を目標空燃比にフィードバック制御する。第2空燃比フィードバック手段は、燃焼混合気の目標空燃比がリーンから理論空燃比又はリッチに切り換えられた直後においてのみ、前記第2空燃比検出手段で検出される排気空燃比に基づいて燃焼混合気の空燃比を目標空燃比にフィードバック制御する。

【0016】かかる構成によると、通常は、NOx吸収触媒の上流側で検出される排気空燃比を目標空燃比に近づけるべくフィードバック制御が行われるが、目標空燃比がリーンから理論空燃比又はリッチに切り換えられた直後、即ち、NOx吸収触媒において吸収したNOxの浄化が行われる条件のときには、上記フィードバック制御に代えて、NOx吸収触媒の下流側で検出される排気空燃比を目標空燃比に近づけるべくフィードバック制御が行われる。

【0017】NOx吸収触媒の下流側の排気空燃比は、上流側に比べてその変化が遅れるから、下流側の排気空燃比に基づく第2空燃比フィードバック制御手段を実行させることで、下流側の排気空燃比の変化を早めることになる。尚、第1，第2空燃比検出手段としては、排気中の酸素濃度に基づいて排気空燃比を検出するセンサを用いることができ、更に、理論空燃比に対するリッチ・リーンのみを検出するストイキセンサの他、排気空燃比を連続的に検出し得る広域空燃比センサを用いても良い。

【0018】請求項5記載の発明では、前記第2空燃比フィードバック手段が、目標空燃比の切り換えから前記第2空燃比検出手段で検出される排気空燃比がリッチに反転するまで間においてフィードバック制御を行う構成とした。かかる構成によると、NOx吸収触媒の下流側の排気空燃比がリーンからリッチに反転するまで、NOx吸収触媒の下流側の排気空燃比を目標空燃比に近づけるようにフィードバック制御され、NOx吸収触媒内が速やかにリッチに反転するようにする。

【0019】請求項6記載の発明では、前記第2空燃比フィードバック手段による空燃比フィードバック制御により、所定の最大時間が経過してもリッチに反転しないときに、前記第2空燃比フィードバック手段による空燃比フィードバック制御を強制的に停止させる強制停止手段を備える構成とした。かかる構成によると、第2空燃比検出手段で検出される排気空燃比に基づく空燃比フィードバック制御を所定時間行ってもリッチに反転しないときには、何らかの異常が発生しているものと判断し、前記空燃比フィードバック制御を停止させてそれ以上のリッチ化を行わない。

【0020】請求項7記載の発明では、前記第2空燃比フィードバック手段による空燃比フィードバック制御によってリッチに反転したときの操作量を学習値として学習する学習手段を備え、前記第2空燃比フィードバック手段が、空燃比フィードバック制御の開始時に前記学習値だけ操作量をステップ変化させる構成とした。かかる構成によると、目標空燃比の切り換え時に、NOx吸収触媒の下流側の排気空燃比がリッチに反転すると、そのときの操作量が、リッチ反転に必要とされた操作量として学習される。そして、第2空燃比検出手段を用いた空燃比フィードバック制御を開始するときに、操作量を前記学習値だけステップ変化させることで、リッチ反転の応答を早める。

【0021】請求項8記載の発明では、前記第2空燃比フィードバック手段による空燃比フィードバック制御により、所定の最小時間以内でリッチに反転したときに、前記学習値を減少修正する学習値減少修正手段を設ける構成とした。かかる構成によると、第2空燃比検出手段を用いた空燃比フィードバック制御で、最小時間よりも早くNOx吸収触媒の下流側がリッチに反転したときには、学習値が過剰に大きいものと推定し、学習値を減少修正し、前記最大時間と最小時間との中間の適正な時間でリッチに反転するようにする。

【0022】請求項9記載の発明では、前記NOx吸収触媒の下流側に配置された三元触媒と、該三元触媒の下流側で排気空燃比を検出する第3空燃比検出手段と、前記第2空燃比検出手段で検出される排気空燃比がリッチに反転した時点における第2空燃比フィードバック制御手段による操作量を、前記第3空燃比検出手段で検出される排気空燃比がリッチに反転するまでの間保持させるリッチ操作量保持手段と、を設ける構成とした。

【0023】かかる構成によると、排気通路に対して上流側から、第1空燃比検出手段，NOx吸収触媒，第2空燃比検出手段，三元触媒，第3空燃比検出手段の順に配置される。そして、前記第2空燃比フィードバック制御手段により第2空燃比検出手段で検出される排気空燃比がリッチに反転すると、該反転時点から第3空燃比検出手段で検出される排気空燃比がリッチに反転するまでの間、前記反転時点における操作量に保持される。

【0024】即ち、前記三元触媒は、NOx吸収触媒で浄化できなかったNOxを浄化するためのものであり、かかるNOx浄化を効率良く行わせるべく、三元触媒内の排気空燃比も速やかにリッチに反転させる必要があるので、NOx吸収触媒内がリッチに反転しても、直ちに

通常制御（第１空燃比フィードバック制御手段による制御）に復帰させるのではなく、ＮＯｘ吸収触媒のリッチ反転に遅れてリッチ化することになる三元触媒のリッチ化を確認してから通常制御に復帰させるものである。

【００２５】請求項10記載の発明では、前記ＮＯｘ吸収触媒の下流側に配置された三元触媒と、前記第２空燃比検出手段で検出される排気空燃比がリッチに反転した時点における第２空燃比フィードバック制御手段による操作量を、その後所定時間保持させる時間によるリッチ操作量保持手段と、を設ける構成とした。かかる構成によると、三元触媒の下流側の排気空燃比をリッチ化させる構成であるが、請求項９記載の発明のように、第３空燃比検出手段を設けて直接に排気空燃比を検出する構成ではなく、ＮＯｘ吸収触媒内をリッチに反転させた操作量を所定時間だけ保持することとで、下流側の三元触媒内もリッチに反転するものと推定するものである。

【００２６】請求項11記載の発明では、前記時間によるリッチ操作量保持手段が、前記三元触媒がリーン雰囲気に晒されていた時間に応じて前記操作量を保持させる時間を変更する構成とした。かかる構成によると、三元触媒がリーン雰囲気に晒されていた時間（リーン時間）が長い場合には、それだけ酸素ストレージ量が多く、リッチに反転するのに時間を要するものと推定されるので、ＮＯｘ吸収触媒をリッチ反転させた操作量を保持させる時間を前記リーン時間に応じて変更する。

【００２７】

【発明の効果】請求項１記載の発明によると、ＮＯｘ吸収触媒に吸収されていたＮＯｘが放出されるときに、ＮＯｘ吸収触媒内を速やかにリッチ化できると共に、ＮＯｘ吸収量の変動などに影響されずに最適な空燃比に制御でき、以て、ＮＯｘを効率良く還元でき、かつ、ＨＣ，ＣＯの排出量の増大を抑制できるという効果がある。

【００２８】請求項２記載の発明によると、ＮＯｘ吸収触媒の下流側に三元触媒を配置して、ＮＯｘ吸収触媒で浄化できなかったＮＯｘの浄化を図れるようになると共に、前記三元触媒内を速やかにリッチ化してＮＯｘ吸収触媒で浄化できなかったＮＯｘを効率良く浄化できるという効果がある。請求項３記載の発明によると、ＮＯｘ吸収触媒の下流側に配置された三元触媒を早期にリッチ化させるための制御を簡便に実行させることができるという効果がある。

【００２９】請求項４記載の発明によると、通常は、ＮＯｘ吸収触媒の上流側に設けた空燃比検出手段を用いてＮＯｘ吸収触媒に導入される排気空燃比を適正に制御できる一方、ＮＯｘ吸収触媒においてＮＯｘ浄化が行われる条件下においては、ＮＯｘ吸収触媒内を速やかにリッチ化することができ、ＨＣ，ＣＯの排出量を抑制しつつＮＯｘを効率良く浄化できるという効果がある。

【００３０】請求項５記載の発明によると、ＮＯｘ吸収触媒をＮＯｘの還元処理に最適な空燃比にまで速やかに変化させることができ、ＮＯｘを効率良く浄化できると共に、ＨＣ，ＣＯの排出量の増大を抑制できるという効果がある。請求項６記載の発明によると、ＮＯｘ吸収触媒の下流側の排気空燃比に基づく空燃比フィードバック制御により過剰にリッチ制御されることを防止できるという効果がある。

【００３１】請求項７記載の発明によると、ＮＯｘ吸収触媒内をリーンからリッチに反転させる制御の応答性を、個々の機関，触媒に応じて適正値に制御できるという効果がある。請求項８記載の発明によると、ＮＯｘ吸収触媒内をリーンからリッチに反転させる制御の応答性が過剰に早くなって、ＨＣ，ＣＯ浄化率が悪化が低下することを防止できるという効果がある。

【００３２】請求項９記載の発明によると、ＮＯｘ吸収触媒の下流側に三元触媒を配置して、ＮＯｘ吸収触媒で浄化できなかったＮＯｘの浄化を図れるようになると共に、前記三元触媒内を速やかに適正レベルにリッチ化させてＮＯｘ吸収触媒で浄化できなかったＮＯｘを効率良く浄化できるという効果がある。請求項10記載の発明によると、ＮＯｘ吸収触媒の下流側に配置された三元触媒を早期にリッチ化させるための制御を、三元触媒の下流側に空燃比検出手段を設けることなく簡便に実行させることができるという効果がある。

【００３３】請求項11記載の発明によると、ＮＯｘ吸収触媒の下流側に配置された三元触媒内を、簡便な構成によって早期に過不足なくリッチ化させることができるという効果がある。

【００３４】

【発明の実施の形態】以下に本発明の実施の形態を説明する。図２は、第１の実施の形態における内燃機関のシステム構成を示す図であり、機関１には、スロットル弁２で計量された空気が吸引され、燃料噴射弁３から噴射される燃料と前記吸入空気とが混合して混合気が形成される。

【００３５】前記燃料噴射弁３は、吸気ポート部分に燃料を噴射するものであっても良いし、また、燃焼室内に直接燃料を噴射するものであっても良い。前記混合気は、点火栓４による火花点火によって着火燃焼し、燃焼排気は、排気通路９に介装されたＮＯｘ吸収触媒５で浄化された後に大気中に排出される。前記ＮＯｘ吸収触媒５は、排気空燃比がリーンであるときに排気中のＮＯｘを吸収し、排気空燃比が理論空燃比又はリッチであるときに前記吸収したＮＯｘを放出して三元触媒層で還元処理する触媒（ＮＯｘ吸収型三元触媒）である。

【００３６】前記燃料噴射弁３による噴射時期，噴射量，及び，点火栓４による点火時期等を制御するコントロールユニット６はマイクロコンピュータを含んで構成され、各種センサからの検出信号に基づく演算処理によって、前記燃料噴射弁３に対して燃料噴射信号（噴射パルス信号）を出力し、点火栓４（パワートランジスタ）

に対しては点火信号を出力する。

【0037】前記燃料噴射信号の演算においては、運転条件に応じて目標空燃比を決定し、該目標空燃比の混合気が形成されるように燃料噴射量（噴射パルス幅）が演算されるが、前記目標空燃比として理論空燃比よりもリーンである空燃比が設定される構成となっている。前記各種センサとしては、機関1の吸入空気流量を検出するエアフローメータ7、前記スロットル弁2の開度を検出するスロットルセンサ8、前記NOx吸収触媒5の上流側の排気通路9に配置されて排気空燃比を検出する第1空燃比センサ10（第1空燃比検出手段）、前記NOx吸収触媒5の下流側の排気通路9に配置されて排気空燃比を検出する第2空燃比センサ11（第2空燃比検出手段）などが設けられる他、コントロールユニット6には図示しないクランク角センサからの回転信号や水温センサからの水温信号などが入力される。

【0038】前記第1空燃比センサ10，第2空燃比センサ11は、排気中の酸素濃度に基づいて排気空燃比を検出するセンサであり、理論空燃比のみを検出するストイキセンサであっても良いし、また、排気空燃比を広域に検出できる広域空燃比センサであっても良い。前記コントロールユニット6は、通常は、前記第1空燃比センサ10で検出される排気空燃比を目標空燃比に近づけるように、前記燃料噴射量を補正するための空燃比フィードバック補正係数（操作量）αを、例えば比例積分制御等により設定する。上記機能が、第1空燃比フィードバック手段に相当する。

【0039】一方、目標空燃比がリーンから理論空燃比又はリッチに切り換えられた直後においては、前記第1空燃比センサ10の代わりに、前記第2空燃比センサ11を用いて前記空燃比フィードバック制御を行うようになっており、かかる第2空燃比フィードバック手段に相当する制御の様子を図3のフローチャートに示してある。図3のフローチャートにおいて、まず、ステップ1（図中にはS1と記してある。以下同様）では、NOx処理空燃比制御の開始条件の成立を示すフラグFRSを判別することで、前記開始条件の成立の有無を判断する。

【0040】前記NOx吸収触媒5は、排気空燃比がリーンであるときに排気中のNOxを吸収し、排気空燃比が理論空燃比又はリッチであるときに前記吸収したNOxを放出するものであるから、目標空燃比がリーンから理論空燃比又はリッチに切り換えられたときには、リーン燃焼中に吸収されたNOxが放出されることになるので、前記フラグFRSに1がセットされて開始条件の成立が判別されるようになっている。

【0041】尚、目標空燃比のリーンから理論空燃比又はリッチへの切り換えは、運転条件（加速，負荷・回転の変化）によって行われる他、本来目標空燃比としてリーン空燃比が設定される条件下であっても、NOx吸収触媒5におけるNOx吸収量が限界量に達していると推定されるときには、一時的にリッチ制御が行われる設定となっており、このNOx処理のための一時的なリッチ制御への切り換えも含むものである。

【0042】目標空燃比のリーンから理論空燃比又はリッチへの切り換えが行われて前記フラグFRSに1がセットされると、ステップ2へ進み、空燃比フィードバック制御に用いる空燃比センサを、それまでの第1空燃比センサ10から第2空燃比センサ11へ切り換える設定を行う。これにより、切り換え後の目標空燃比に、第2空燃比センサ11で検出される排気空燃比を近づけるための空燃比フィードバック制御が行われる。

【0043】そして、ステップ3では、前記第2空燃比センサ11で検出されるNOx吸収触媒5下流側の排気空燃比が、リーンからリッチに反転したか否かを判別する。尚、第2空燃比センサ11として空燃比を広域に検出できるセンサを用いる場合には、前記ステップ3における判定を、目標空燃比へ到達したか否かとしても良い。ステップ3でNOx吸収触媒5の下流側の空燃比がリッチに反転したことが判別されると、ステップ4へ進んで、前記フラグFRSをゼロにリセットし、次のステップ5では、空燃比フィードバック制御に用いる空燃比センサを、第2空燃比センサ11から第1空燃比センサ10に戻す設定を行う。

【0044】上記図3のフローチャートに従った制御の特性を図4のタイムチャートに示してある。尚、図4のタイムチャートは、空燃比センサとしてストイキセンサを用いた場合であって、運転条件によって目標空燃比がリーンから理論空燃比（ストイキ）に切り換えられた場合を示してある。前記フラグFRSに1がセットされると（目標空燃比がリーンからストイキに切り換えられると）、空燃比フィードバック制御に用いる空燃比センサが第1空燃比センサ10から第2空燃比センサ11に切り換えられ、第2空燃比センサ11を用いた空燃比フィードバック制御が開始される。

【0045】このとき、第1空燃比センサ10で検出されるNOx吸収触媒5上流側の排気空燃比は比較的早くリッチに反転するが、第2空燃比センサ11のリッチ反転はNOx吸収触媒5におけるNOx及びO_2の脱離によって遅れるために、第1空燃比センサ10で検出される排気空燃比がリッチに反転しても、更に、第2空燃比センサ11のリッチ反転までは燃料噴射量が徐々に増量されてリッチスパイクが与えられ、結果的に、第2空燃比センサ11（NOx吸収触媒5内）のリッチ反転を早めることになる。

【0046】前記NOx吸収触媒5におけるNOx処理には、リッチスパイクを与えることが有効であるから、上記のようにしてNOx吸収触媒5内を速やかにリッチ雰囲気にできれば、効率良くNOxを還元処理できることになる。また、第2空燃比センサ11のリッチ反転を基準としてリッチ化を進めることで、経時劣化によってN

Ｏｘ吸収量や酸素ストレージ量の変化があっても、過剰なリッチ化によってＨＣ，ＣＯの排出量が増大することを抑制できる。

【００４７】そして、第２空燃比センサ11で検出される排気空燃比がリーンからリッチに反転すると、その時点で第２空燃比センサ11を用いた空燃比フィードバック制御（第２空燃比フィードバック手段）を停止し、代わりに、第１空燃比センサ10を用いた空燃比フィードバック制御（第１空燃比フィードバック手段）が開始され、ＮＯｘ吸収触媒５上流側の排気空燃比を理論空燃比に近づけるようにフィードバックされる。

【００４８】図５のフローチャートは、前記図３のフローチャートに示される基本的な制御内容をベースとしてより詳細な処理内容を示すものであり、以下、前記図４及び図６のタイムチャートを参照しつつ、前記図５のフローチャートを説明する。ステップ11では、前記フラグＦＲＳの判別を行い、前記フラグＦＲＳに１がセットされると、ステップ12へ進む。

【００４９】ステップ12では、空燃比フィードバック制御に用いる空燃比センサを、第１空燃比センサ10から第２空燃比センサ11に切り換える。ステップ13では、第２空燃比センサ11を用いた空燃比制御の時間を計測するためのタイマＴαをゼロリセットし、また、空燃比フィードバック補正係数α（燃料噴射量を補正するための操作量）に初期値（100 ％）をリセットする。

【００５０】ステップ14では、空燃比フィードバック補正係数αを前記初期値から一律リッチ分ＫＮα＋学習値ＬＮαだけステップ的に増大変化させる（図６参照）。前記一律リッチ分ＫＮαは固定値であり、前記学習値ＬＮαは、前記第２空燃比センサ11の検出結果がリッチに反転した時点の補正係数αを学習した値であり、後に詳述する。

【００５１】ステップ15では、前記タイマＴαをカウントアップし、次のステップ16では、前記タイマＴαが、予め設定された最大値Ｔαmax （図６参照）未満であるか否かを判別する。前記タイマＴαが最大値Ｔαmax 未満であれば、ステップ17へ進み、前記補正係数αを積分分αだけ増大修正する。

【００５２】前記積分制御で増大された補正係数αは、次のステップ18で予め設定された最大値αmax （図６参照）と比較され、補正係数αが最大値αmax 以上であるときには、ステップ19へ進み、補正係数αに最大値αmax をセットすることで、補正係数αが最大値αmax を超えることを回避する。これにより、過剰なリッチスパイクとなることを防止する。

【００５３】尚、前記ステップ17における積分制御を省略し、空燃比フィードバック補正係数αを前記一律リッチ分ＫＮα＋学習値ＬＮαだけステップ的に増大変化させた状態でそのまま保持させて、第２空燃比センサ11で検出される空燃比がリッチに反転するのを待つ構成としても良い。ステップ20では、第２空燃比センサ11の出力がリッチに反転したか否かを判別する。そして、リッチに反転したときには、所期のリッチスパイクを与えることができたものとして、通常制御（第１空燃比フィードバック手段）に復帰させるが、まず、ステップ21へ進み、前記タイマＴαが最小値Ｔαmin 以下であるか否かを判別する。

【００５４】タイマＴαが最小値Ｔαmin を越えてからリッチ反転したときには、ステップ22へ進み、下式（１式）に従って前記学習値ＬＮαの更新演算を行う。このステップ22の部分が、学習手段に相当する。

ＬＮα＝（（ｎ－１）×ＬＮα（旧）＋α’）／ｎ

上式で、ＬＮα（旧）は更新前の学習値であり、α’はリッチに反転したときの補正係数αを示す。そして、予め設定された重み係数ｎによって、更新前の学習値ＬＮα（旧）とリッチ反転時の補正係数α’とが平均化され、該平均化後の値が新たな学習値ＬＮαとして更新記憶される。

【００５５】これにより、第２空燃比センサ11に切り換えられた直後のステップ変化量として、第２空燃比センサ11の出力をリッチに反転させるのに要求される最適な値を与えることができる。尚、前記学習値ＬＮαを、リッチ反転時における負荷，回転条件毎に演算して記憶させるようにしても良い。

【００５６】また、前記ステップ16で、前記タイマＴαが最大値Ｔαmax 以上であると判別されたときにも、ステップ22へ進んで、上式に従って学習値ＬＮαを更新させる。この場合、前記補正係数α’は、前記タイマＴαが最大値Ｔαmax になった時点の最終値として与える。上記のように、前記タイマＴαが最大値Ｔαmax 以上になったときには、リッチ反転を待たずに、通常制御に強制的に復帰させることで、過剰にリッチ制御が継続されることを防止するものであり、ステップステップ16からステップ22へ進む処理が強制停止手段に相当する。

【００５７】一方、ステップ21で、タイマＴαが最小値Ｔαmin 未満の状態でリッチ反転した判断されるときには、ステップ23へ進んで、下式（２式）に従って前記学習値ＬＮαの更新演算を行う。このステップ23の部分が、学習値減少修正手段に相当する。

ＬＮα＝ＤＮα×ＬＮα（旧）

前記ＤＮαは、学習値ＬＮαを減少修正するための係数（ＤＮα＜１）であり、リッチ反転に要した時間が異常に短い場合には、学習値ＬＮαを減少修正することで、リッチ反転に要する時間が最小値Ｔαmin を越えるようにし、ＮＯｘ処理に適正な応答性でリッチ反転させるようにする。

【００５８】ステップ24では、前記補正係数αを初期値（（100 ％）に戻し、次のステップ25では、前記フラグＦＲＳをゼロリセットし、更に、ステップ26では、空燃比フィードバック制御に用いる空燃比センサを、第２空

燃比センサ11から第1空燃比センサ10に戻し、その後は、第1空燃比センサ10の検出結果に基づいて通常の空燃比フィードバック制御（第1空燃比フィードバック手段）が行われるようにする。

【0059】ところで、上記のようにリーン燃焼中にNOx吸収触媒5に吸収されたNOxを処理するときに、第2空燃比センサ11を用いた空燃比フィードバック制御を行うことで、NOx吸収触媒5内をNOx処理に適正な空燃比雰囲気に早期に制御できるが、上記制御によってもNOx吸収触媒5の下流側にNOxが排出されたり、リッチスパイクによりHC，COが排出される可能性がある。

【0060】そこで、図7に示す第2の実施の形態のように、前記NOx吸収触媒5の下流側に三元触媒12を配置し、NOx吸収触媒5で浄化できなかったNOx，HC，COを前記三元触媒12で処理するよう構成すると良い。更に、前記三元触媒12で処理を効率良く行わせるために、図8のフローチャートに示すようにして、空燃比制御を行わせると良い。

【0061】図8のフローチャートにおいて、ステップ31からステップ40までの各ステップは、前述の図5のフローチャートのステップ11～ステップ20と全く同様な処理を行うものであり、前記フラグFRSに1がセットされると（目標空燃比がリーンから理論空燃比又はリッチに切り換えられると）、第2空燃比センサ11の出力がリッチ反転するまで、積分制御によって空燃比フィードバック補正係数αを増大制御させる。

【0062】そして、ステップ40で、第2空燃比センサ11の出力がリッチ反転したことが判別されると、次のステップ41では、リーン制御時間、即ち、目標空燃比をリーンとする空燃比制御状態の継続時間に応じて予め保持時間NRTを記憶したテーブルTNRTを参照して、前記空燃比フィードバック補正係数αを保持させる保持時間NRTを決定する。ここで、図9に示すように、前記リーン時間が長いときほど前記保持時間TNRTを長く設定するようにする。

【0063】ステップ42では、第2空燃比センサ11の出力がリッチ反転した時点における空燃比フィードバック補正係数αを、前記保持時間NRTだけ保持させるようにし（図10参照）、前記保持時間NRTが経過してからステップ43へ進む。上記ステップ41，42の部分が、時間によるリッチ操作量保持手段に相当する。ステップ43～48の各ステップは、前記図5のフローチャートのステップ21～26と同様な処理を行うものであり、学習値LNαの更新演算を行った後、第1空燃比センサ10による通常の空燃比フィードバック制御（第1空燃比フィードバック手段）に復帰させる。

【0064】上記のように、NOx吸収触媒5内がリッチ雰囲気になってからも、そのときの空燃比フィードバック補正係数αを保持時間NRTだけ保持させることで、三元触媒12内を早期にリッチ雰囲気にして、NOx吸収触媒5で浄化されないで排出されるNOxを効率良く浄化させることができる。上記図8のフローチャートに示す実施の形態では、リーン時間に応じて三元触媒12内がリッチ反転するのに要する時間が変化するものとして、リーン時間に応じた保持時間NRTだけ空燃比フィードバック補正係数αを保持させるようにしたが、三元触媒12内の空燃比をより最適に制御するために、図11に示す第3の実施の形態のように、三元触媒12の下流側に第3空燃比センサ13（第3空燃比検出手段）を配置し、該第3空燃比センサ13の検出結果に基づいて空燃比フィードバック補正係数αを保持させる期間を制御させるようにしても良い。

【0065】尚、前記第3空燃比センサ13も、ストイキセンサ又は広域空燃比センサのいずれであっても良い。前記第3空燃比センサ13を用いた制御の様子を図12のフローチャートに示してある。図12のフローチャートにおいて、ステップ51からステップ60までの各ステップは、前述の図5のフローチャートのステップ11～ステップ20と全く同様な処理を行うものであり、前記フラグFRSに1がセットされると、第2空燃比センサ11の出力がリッチ反転するまで、積分制御によって空燃比フィードバック補正係数αを増大制御させる。

【0066】そして、ステップ61では、第2空燃比センサ11がリッチ反転した時点の空燃比フィードバック補正係数αを保持させる設定を行い、次のステップ62では、前記第3空燃比センサ13の出力がリッチ反転したか否かを判別する。ステップ62で、第3空燃比センサ13のリッチ反転が判別されるまでは、ステップ61に戻って空燃比フィードバック補正係数αの保持状態を維持させ、第3空燃比センサ13がリッチ反転した時点でステップ63へ進む（図13参照）。

【0067】上記ステップ61，62の部分がリッチ操作量保持手段に相当する。ステップ63～68の各ステップは、前記図5のフローチャートのステップ21～26と同様な処理を行うものであり、学習値LNαの更新演算を行った後、第1空燃比センサ10による通常の空燃比フィードバック制御に復帰させる。上記のように、第3空燃比センサ13がリッチ反転するまで空燃比フィードバック補正係数αを保持させる構成であれば、保持時間を最適に制御することができ、保持時間が不足して三元触媒12で効率良くNOxを浄化できなかったり、逆に、保持時間が長過ぎて過剰なリッチスパイクが与えられてしまうことを回避できる。

【図面の簡単な説明】

【図1】請求項1記載の発明に係る排気浄化装置の基本構成を示すブロック図。

【図2】第1の実施の形態における内燃機関のシステム構成図。

【図3】第1の実施の形態における基本的な空燃比制御

の様子を示すフローチャート。

【図4】第1の実施の形態における空燃比制御の特性を示すタイムチャート。

【図5】第1の実施の形態における空燃比制御を詳細を示すフローチャート。

【図6】第1の実施の形態における空燃比フィードバック補正係数の特性を示すタイムチャート。

【図7】第2の実施の形態における内燃機関のシステム構成図。

【図8】第2の実施の形態における空燃比制御の詳細を示すフローチャート。

【図9】第2の実施の形態における保持時間NRTとリーン時間との相関を示す線図。

【図10】第2の実施の形態における空燃比制御の特性を示すタイムチャート。

【図11】第3の実施の形態における内燃機関のシステム構成図。

【図12】第3の実施の形態における空燃比制御の詳細を示すフローチャート。＊

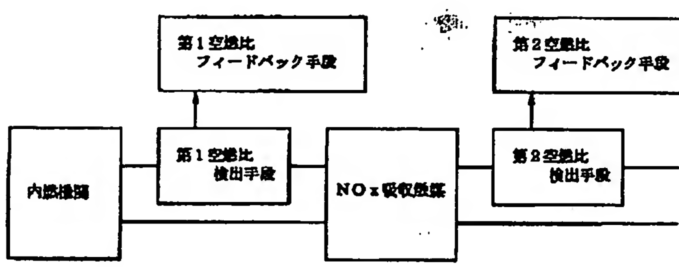
＊【図13】第2の実施の形態における空燃比制御の特性を示すタイムチャート。

【図14】従来制御の問題点を説明するためのタイムチャート。

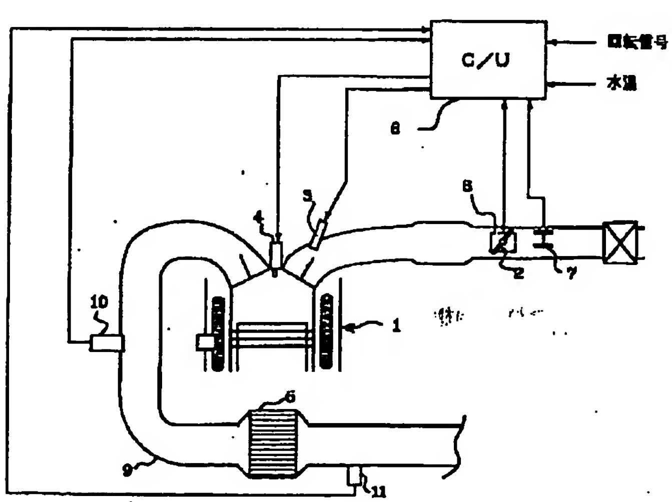
【符号の説明】

1　内燃機関
2　スロットル弁
3　燃料噴射弁
4　点火栓
5　NOx吸収触媒
6　コントロールユニット
7　エアフローメータ
8　スロットルセンサ
9　排気通路
10　第1空燃比センサ
11　第2空燃比センサ
12　三元触媒
13　第3空燃比センサ

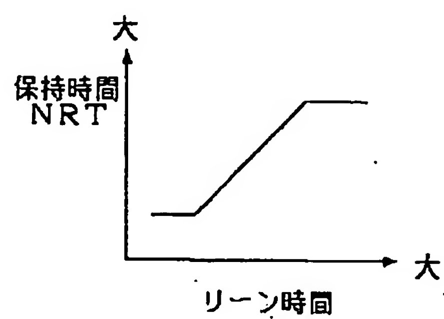
【図1】



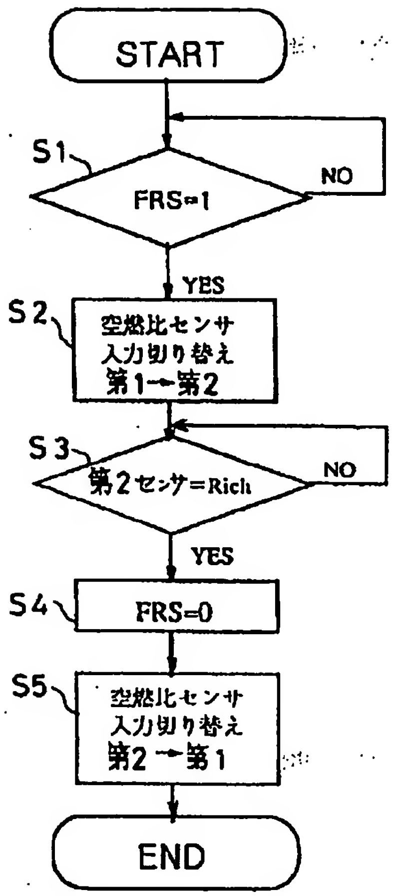
【図2】



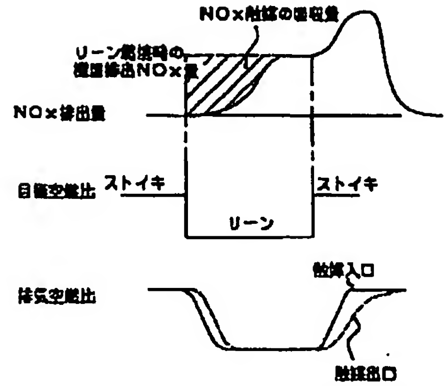
【図9】



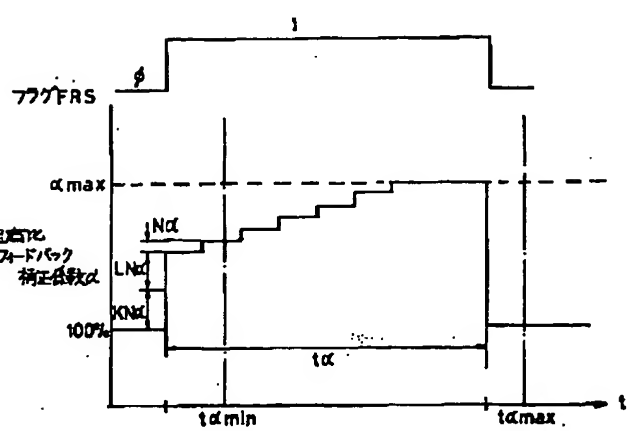
【図3】


START
S1
FRS=1
NO
YES
S2
空燃比センサ
入力切り替え
第1→第2
S3
第2センサ=Rich
NO
YES
S4
FRS=0
S5
空燃比センサ
入力切り替え
第2→第1
END

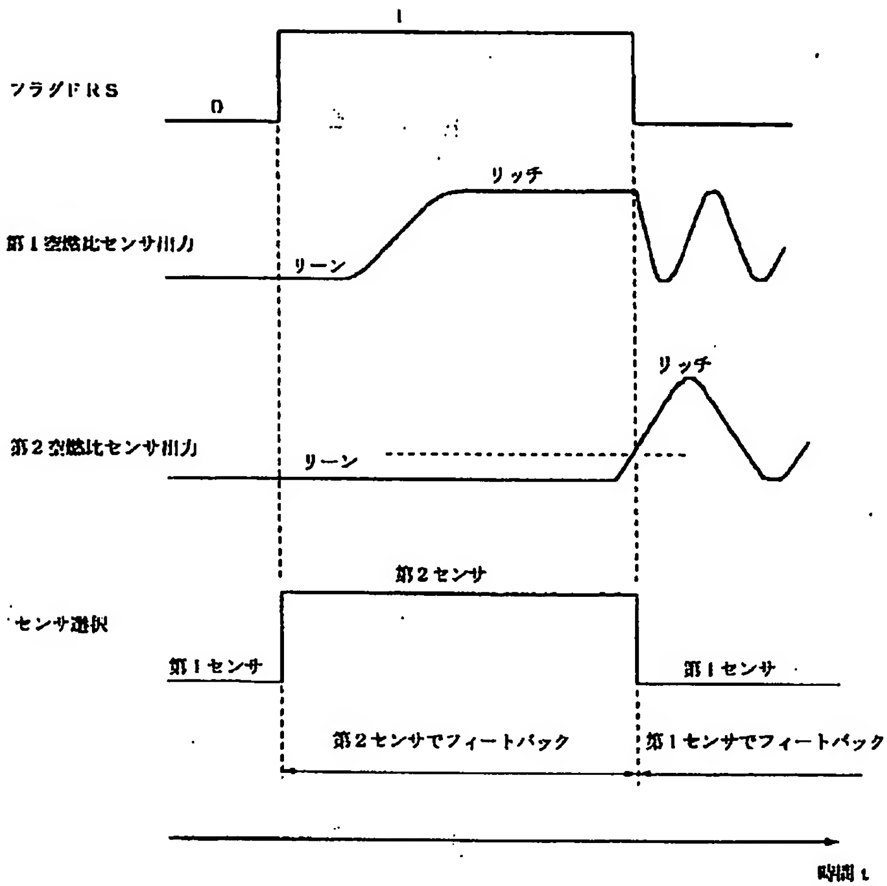
【図14】


NOx排出量
目標空燃比
ストイキ
リーン
ストイキ
排気空燃比
触媒入口
触媒出口

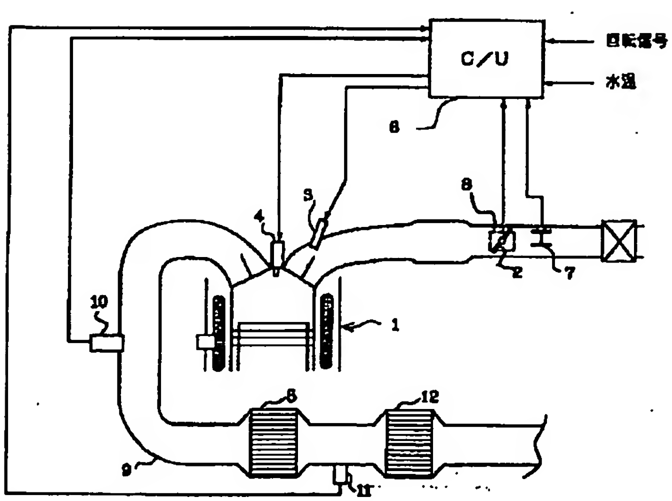
【図6】


1
ϕ
フラグFRS
αmax
Nα
空燃比
フィードバック
補正係数α
LNα
KNα
100%
tα
tαmin
tαmax
t

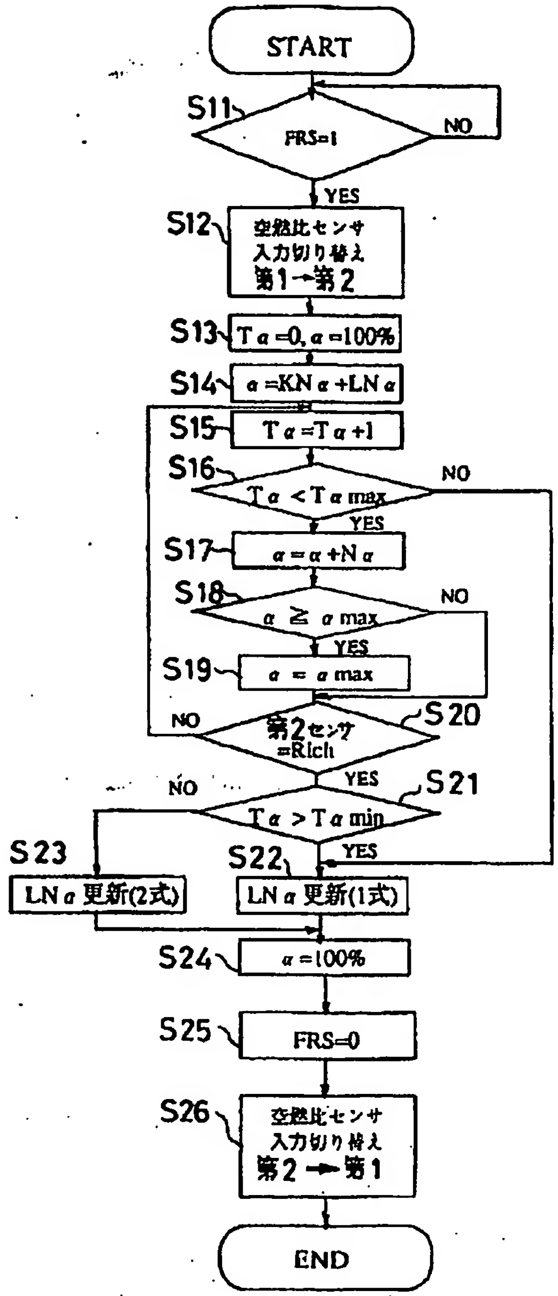
【図4】


1
フラグFRS
0
リッチ
第1空燃比センサ出力
リーン
リッチ
第2空燃比センサ出力
リーン
第2センサ
センサ選択
第1センサ
第1センサ
第2センサでフィードバック
第1センサでフィードバック
時間t

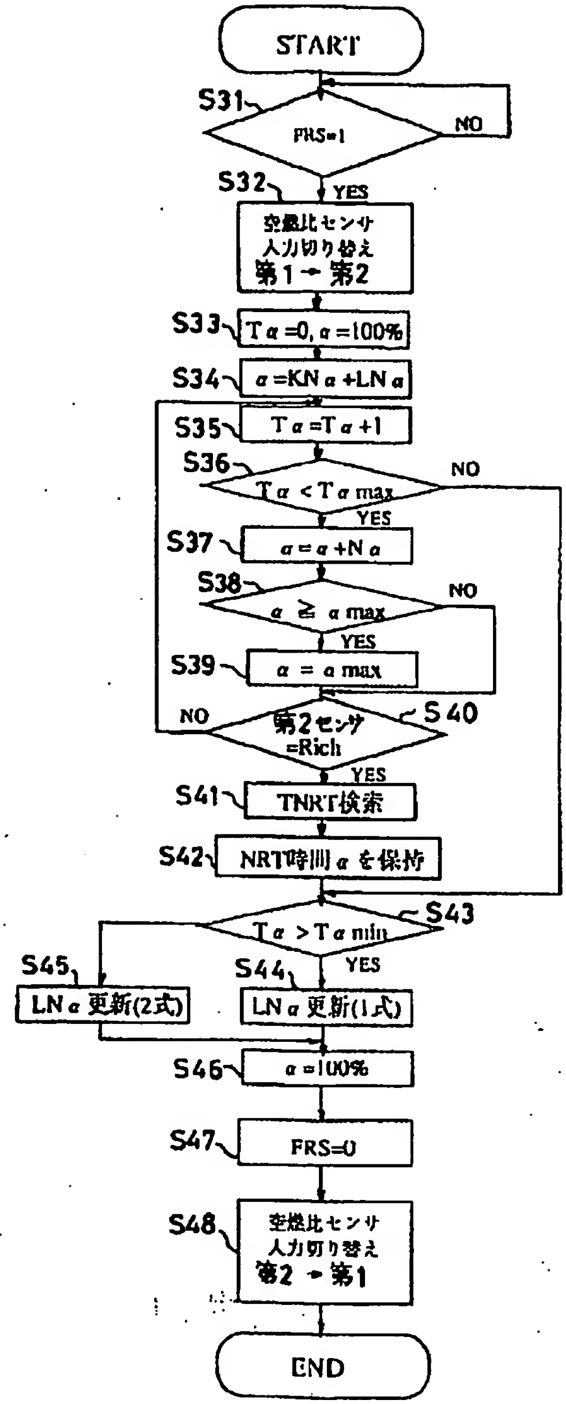
【図7】


C／U
回転信号
水温
6
8
3
4
2
7
10
1
5
12
9
11

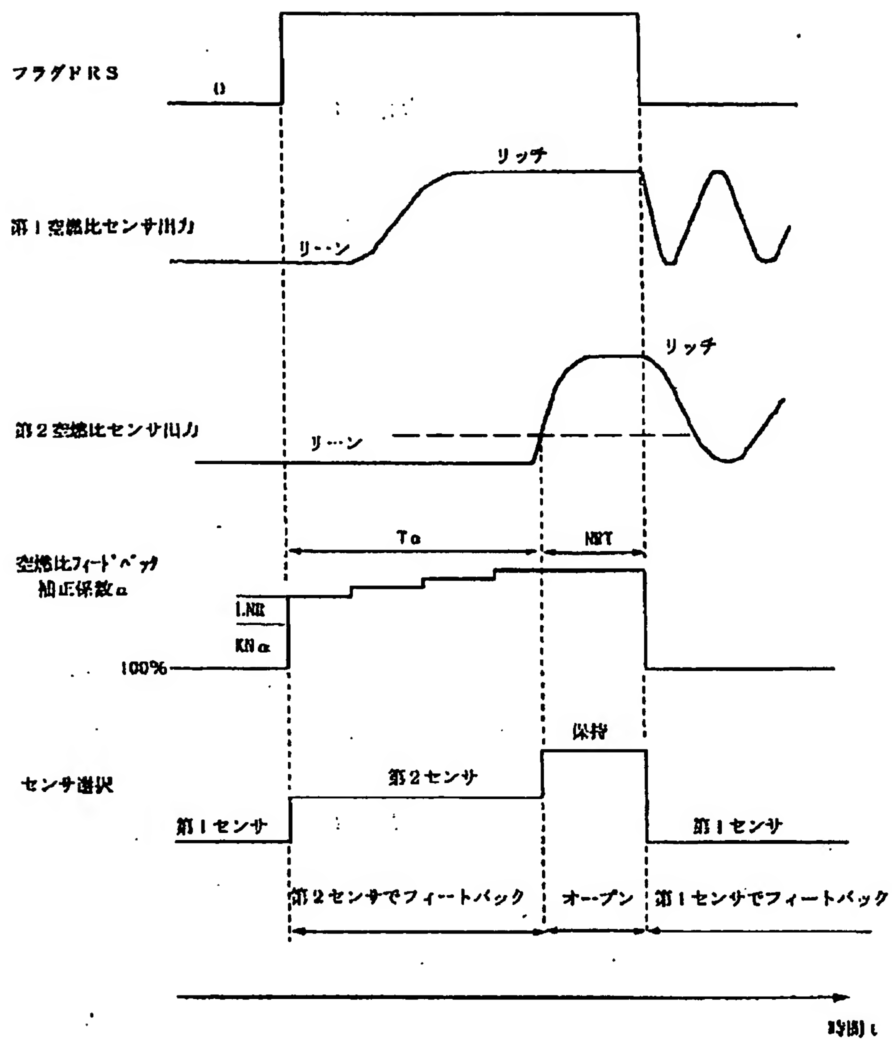
【図5】


START
S11
FRS=1
NO
YES
S12
空燃比センサ
入力切り替え
第1→第2
S13
Tα=0, α=100%
S14
α=KNα+LNα
S15
Tα=Tα+1
S16
Tα<Tα max
NO
YES
S17
α=α+Nα
S18
α ≧ α max
NO
YES
S19
α = α max
S20
第2センサ
=Rich
NO
YES
S21
Tα>Tα min
NO
YES
S23
LNα 更新(2式)
S22
LNα 更新(1式)
S24
α=100%
S25
FRS=0
S26
空燃比センサ
入力切り替え
第2→第1
END

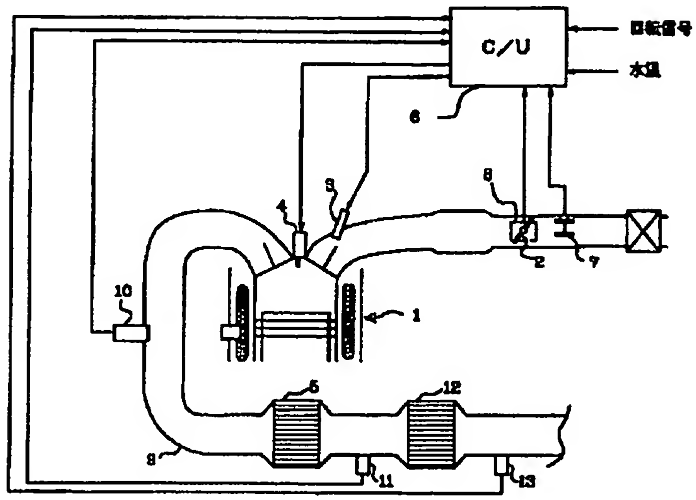
【図8】


START
S31
FRS=1
NO
S32
YES
空燃比センサ
入力切り替え
第1→第2
S33
Tα=0, α=100%
S34
α=KNα+LNα
S35
Tα=Tα+1
S36
Tα<Tα max
NO
YES
S37
α=α+Nα
S38
α ≧ α max
NO
YES
S39
α = α max
NO
第2センサ
=Rich
S40
YES
S41
TNRT検索
S42
NRT時間αを保持
Tα>Tα min
S43
S45
S44
YES
LNα更新(2式)
LNα更新(1式)
S46
α=100%
S47
FRS=0
S48
空燃比センサ
入力切り替え
第2→第1
END

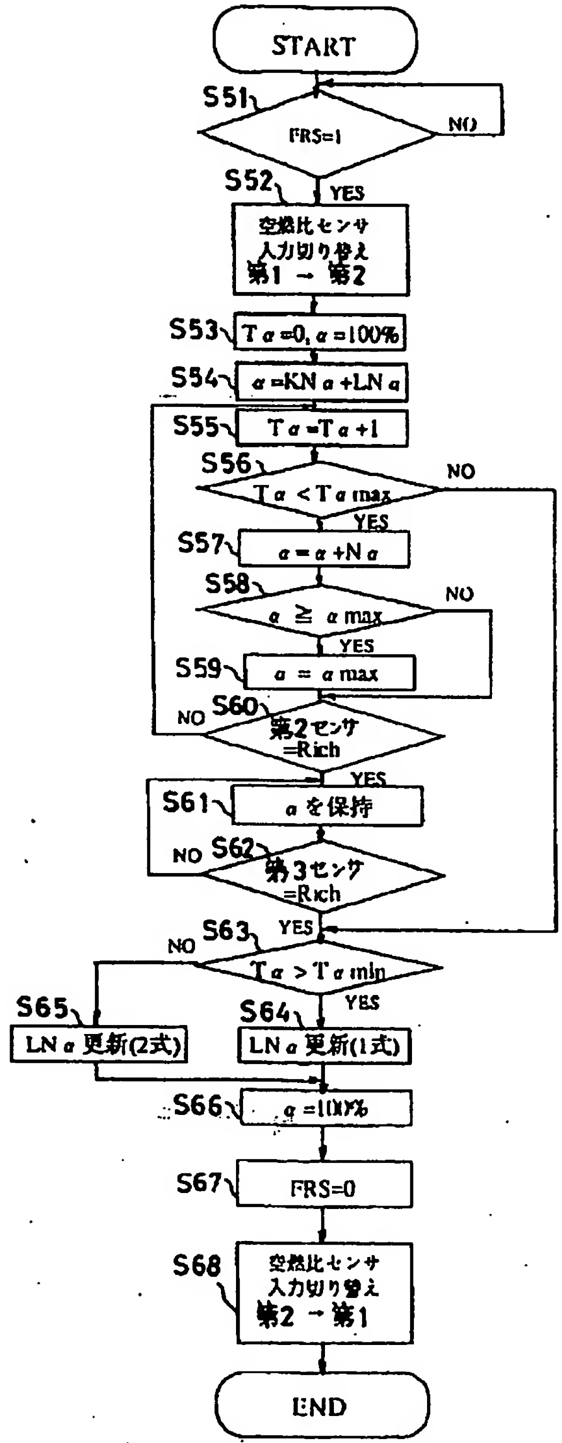
【図10】


フラグＦＲＳ
0
リッチ
第１空燃比センサ出力
リーン
リッチ
第２空燃比センサ出力
リーン
Tα
NRT
空燃比フィードバック
補正係数α
LNR
KNα
100%
保持
センサ選択
第２センサ
第１センサ
第１センサ
第２センサでフィードバック
オープン
第１センサでフィードバック
時間ｔ

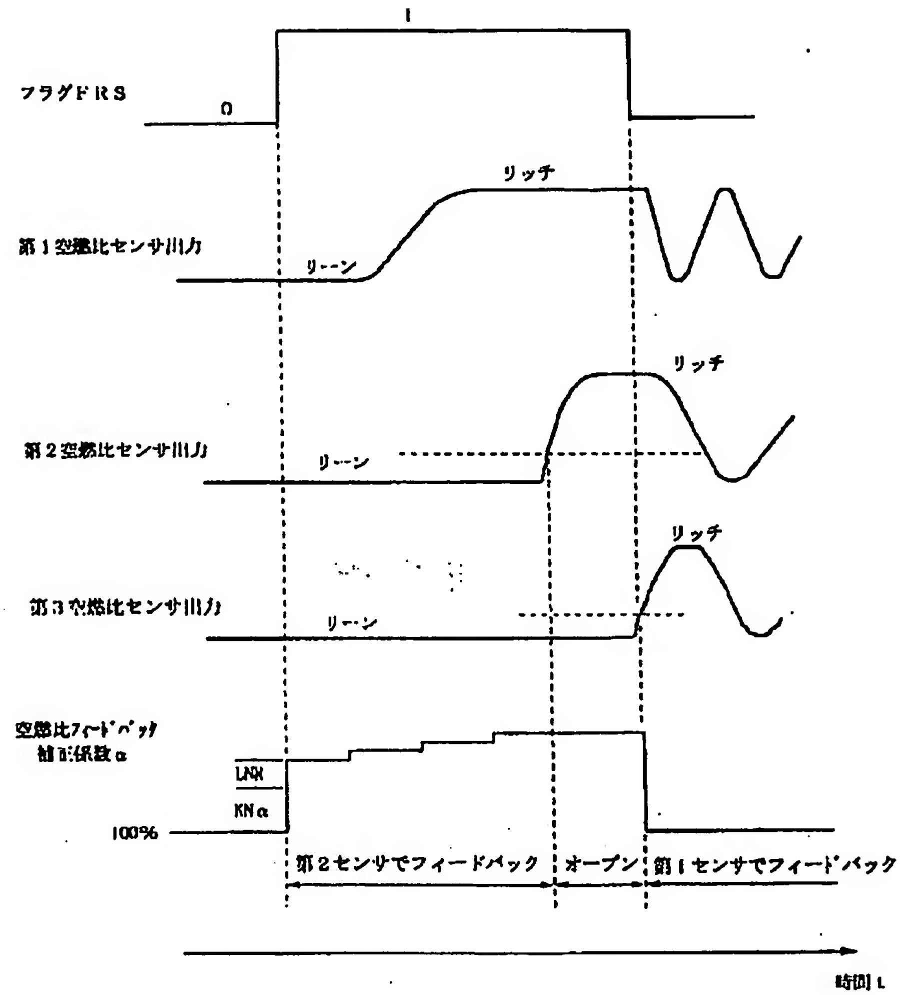
【図11】



【図12】


START
S51
FRS=1
NO
S52
YES
空燃比センサ
入力切り替え
第1 → 第2
S53
Tα=0, α=100%
S54
α=KNα+LNα
S55
Tα=Tα+1
S56
Tα<Tαmax
NO
YES
S57
α=α+Nα
S58
α ≧ αmax
NO
YES
S59
α = αmax
S60
NO
第2センサ
=Rich
YES
S61
αを保持
S62
NO
第3センサ
=Rich
YES
S63
NO
Tα>Tαmin
YES
S65
LNα更新(2式)
S64
LNα更新(1式)
S66
α=100%
S67
FRS=0
S68
空燃比センサ
入力切り替え
第2 → 第1
END

【図13】



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	305		305B

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